



Staten Island/New Jersey Urban Air Toxics Assessment Project

Summary of the Project Report

**STATEN ISLAND/NEW JERSEY URBAN AIR TOXICS ASSESSMENT PROJECT
SUMMARY OF THE PROJECT REPORT**

EPA/902/R-93-002

CONTENTS

1. DESCRIPTION OF THE PROJECT	1
2. ORGANIZATION OF THE PROJECT REPORT	1
3. HISTORY	2
4. SAMPLING	3
5. ANALYSES OF THE AMBIENT AIR CONCENTRATION DATA	4
6. EXPOSURE AND RISK ASSESSMENTS	4
7. EMISSION INVENTORY	6
8. SOURCE IDENTIFICATION	8
9. RESULTS	10
10. CONCLUSIONS	15
11. ADJUNCT STUDY: CITIZEN'S ODOR COMPLAINT NETWORK	17
MAPS AND TABLES	18

STATEN ISLAND/NEW JERSEY URBAN AIR TOXICS ASSESSMENT PROJECT SUMMARY OF THE PROJECT REPORT

1. DESCRIPTION OF THE PROJECT

The Staten Island/New Jersey Urban Air Toxics Assessment Project (SI/NJ UATAP) was a program of ambient air monitoring and meteorological data collection conducted from October 1987 through September 1989, and indoor air sampling conducted from July 1990 through mid-March 1991. An emission inventory was developed to assist in source identification and support risk management where the risk assessment indicated such a need. The study area consisted of Staten Island and nearby New Jersey, directly across the Arthur Kill from Staten Island. (See Map 1.) The project was a cooperative undertaking by the U.S. Environmental Protection Agency Region II, the New York State Department of Environmental Conservation, the New York State Department of Health, the New Jersey Department of Environmental Protection and Energy, the College of Staten Island (CSI), and the University of Medicine and Dentistry of New Jersey.

Concentrations of 40 pollutants were measured in ambient (outdoor) air. The risk assessment focused on the 20 pollutants for which adequate toxicological and concentration data were available. Source identification efforts demonstrated how the project emission inventory for 12 volatile organic compounds (VOCs) can be used with concentration data and meteorological data to associate high concentrations with potential sources of individual pollutants.

A less extensive indoor air study was conducted for use in the risk assessment.

Data analyses and source identification presented in this document refer to work done with the ambient air data, unless indicated otherwise.

2. ORGANIZATION OF THE PROJECT REPORT

The report for the SI/NJ UATAP has been organized into six volumes.

Volume I provides a summary of the overall program and a description of the contents of the remaining volumes.

Volume II provides the organization and functioning of the project, brief descriptions of the methods of sampling and

analysis, and the formats of the data reports. The organizational structure consisted of the Management/Steering Committee, Project Work Group, Technical Subcommittees, and Advisory Group. The detailed workplans of the seven Technical Subcommittees are provided in the Volume VI, Appendices.

Volume III, divided into Part A for VOCs and Part B for particulates and formaldehyde, reports the results obtained from analysis of two years of ambient air samples. The data are presented in tabular and graphical forms. The findings are discussed in terms of their significance with regard to the objectives of the program.

Results of the eight-month indoor air study, initiated near the end of the two-year ambient air sampling program, are presented in Volume IV.

The ambient air VOC concentration data were analyzed for statistical significance of apparent intersite differences. A health risk assessment was prepared using the results of the ambient air monitoring and indoor air monitoring, and statistical analysis inputs. The results are presented in Volume V.

Volume VI, divided into Part A and Part B, is a compilation of detailed workplans and quality assurance (QA) plans of the subcommittees, QA reports of the sampling and analytical organizations and of the QA Subcommittee, descriptions of the sampling sites, and a reference paper on air emissions from publicly-owned treatment works (POTWs). While this material is not required for an understanding of the data analyses and interpretations presented, it provides the basis for a more thorough understanding of the program.

The project report will be available for use at federal depository libraries. The report and summary concentration data for the project may be purchased from the National Technical Information Service (NTIS), an agency within the Technology Administration of the U.S. Department of Commerce, by telephoning (703) 878-4650, or by writing to NTIS, 5285 Port Royal Road, Springfield, VA 22161. The project report is designated EPA document numbers EPA/902/R-93-001a through h; and the summary data set, NTIS accession number PB92-504174.

3. HISTORY

The study was undertaken in response to concerns of the residents of Staten Island that their health might be at serious risk due to exposure to toxic air pollutants emitted routinely by industrial sources in the area, as well as by episodic releases

often characterized by disagreeable odors. Staten Island is bordered on the west by a complex of major industries including pharmaceutical plants, oil refineries, and chemical storage facilities, all of which are sources of VOCs for which ambient air concentration data were not available. Other potential sources of toxic and/or odorous organic compounds include sewage treatment plants and the 1400-acre Fresh Kills Landfill, the world's largest landfill.

A number of studies had concluded that residents of Staten Island had experienced a higher incidence of cancers than other communities of similar socioeconomic status.¹ Reflecting the concerns of their constituents, elected officials and other representatives of Staten Island asked state and federal officials to investigate the causes of recurrent odor episodes, and to determine whether or not emissions from neighboring industrial sources might be responsible for suspected excess cancer incidences in the area.

4. SAMPLING

Location of the ambient air samplers was based on consideration of the following: residential neighborhood complaints, availability, accessibility, security, absence of known point sources nearby, geographic distribution, proximity to breathing zone, and consistency with the U.S. EPA air monitor siting requirements. Map 1 shows the monitor types and locations and Table 1 lists the addresses of the sampling sites. Tables 2 and 3 list the pollutants measured in the SI/NJ UATAP. Ambient air samples were collected on every sixth day from October 1987 through September 1989; more complete data sets were obtained for some pollutants and sites than for others. CSI collected VOC samples almost daily for the first one and a half years of the study.

Concentrations of 40 pollutants--22 VOCs, 16 metals, benzo[a]pyrene (BaP), and formaldehyde--in ambient air were measured using sorbent samplers for VOCs at 13 sites, hi-volume samplers for metals and BaP at 5 sites, and aldehyde-specific samplers for formaldehyde at 5 sites.

In the indoor study, 12 VOCs were measured in two homes in New Jersey and two homes in Staten Island, with simultaneous

¹ The Agency for Toxic Substances and Disease Registry (ATSDR) reviewed three of these studies and found them flawed and not supportive of the asserted association between cancer incidence and air pollution.

measurements at one outdoor site near each set of homes. Samples were taken every twelfth day using canisters. Unlike the ambient air sampling network, this limited indoor air study was not designed to represent indoor air quality in the study area as a whole.

5. ANALYSES OF THE AMBIENT AIR CONCENTRATION DATA

Tables and graphs generated for use in analysis of the ambient air data included the following:

- annual average concentration data summaries for individual pollutants ;
- annual average concentration data for VOCs at all sites;
- annual average concentration data for metals, BaP, and formaldehyde at all sites;
- annual average concentration vs. sampling site for individual pollutants;
- daily concentration vs. sampling date for a single pollutant at a set of sites; and
- daily concentration vs. sampling date for a set of pollutants at a single site.

Tables 4 through 6 and Figures 1 through 3 are examples of this work.

6. EXPOSURE AND RISK ASSESSMENTS

Exposure to air pollutants in the project study area was characterized qualitatively by comparing the measured pollutant levels with typical levels of those pollutants in other U.S. cities; Figure 4 provides an example. The results of the U.S. EPA's Urban Air Toxics Monitoring Program (UATMP) for sites nationwide in 1988 and 1989 were selected for this comparison; they provide concentration data for virtually all of the pollutants quantitated in the SI/NJ UATAP, and do so for urban areas nationwide during the years of ambient air monitoring for this study. Unlike the case of the SI/NJ UATAP, placement of monitors in residential areas was not a siting criterion for the UATMP; however, the microinventory, described in Section 7 of this report, attests to the frequent occurrences in the highly industrialized SI/NJ UATAP study area of major sources close to the residential neighborhoods where samplers were located. The

Quantitative exposure and risk assessments were conducted to characterize human health risks for the study chemicals for which toxicological information (e.g., inhalation reference concentrations and carcinogen unit risk factors) and air concentration data from the study were available. These conditions limited the scope of the quantitative risk assessment to 20 of the 40² study chemicals--9 VOCs, 9 metals, benzo[α]pyrene (BaP), and formaldehyde. Toxicological data available on pollutant effects as determined from experimental exposure of laboratory animals or, for some pollutants, from human exposures, were used to estimate the risk (likelihood or probability) of the incidence of adverse health effects at the pollutant concentrations measured.

These risks were expressed by comparing the measured concentrations to levels considered to be substantially without appreciable risk in the case of noncancer effects, and, in the case of cancer, by estimating the increased risk of cancer from exposure to the measured pollutant concentrations. Both types of risk estimates are termed "increased risk" to indicate that they do not express the total risk of the particular health effect. Many other environmental, socio-demographic, and genetic factors contribute to an individual's total risk of cancer and other adverse health conditions.

Three approaches to quantitative risk assessment for the project data are presented. The Level 1 risk assessments assume that an individual is exposed for an entire lifetime to the annual average air pollutant concentrations recorded at one of the project monitors for the period from October 1, 1988, through September 30, 1989. The Level 2 risk assessments use the indoor and outdoor air concentration data for the 13 VOCs quantitated during the period from July 10, 1990, through March 19, 1991, and assume that body weight and inhalation rate vary over the lifetime of the individual. The Level 2 assessments were conducted in recognition of the finding that exposure to some pollutants via indoor air can be greater than that via ambient air. The additive risk assessment uses the results of the Level 1 assessments to arrive at estimates of the risk of cancer (not distinguished by type of cancer) and of noncancer effects.

The risk assessments presented in this report employed methodologies outlined in EPA guidelines. (U.S. EPA, 1986a, 1986b, 1986c, 1992).

Note that the risk assessments for the SI/NJ UATAP are not complete assessments of risk arising from air pollution in Staten Island and nearby New Jersey since (1) the study compounds do not

² In this tally, m- and p-xylene are counted as one of the 40 chemicals.

represent all the pollutants in ambient air, and (2) exposure via routes other than direct inhalation of ambient air (i.e., via ingestion and dermal contact) are not addressed.

7. EMISSION INVENTORY

The development of an air toxics emission inventory for the SI/NJ UATAP area was considered essential in understanding urban air toxics problems found in the area, and facilitating evaluation of general abatement strategies for toxic air pollutants. The inventory included only those discharges, whether direct or indirect, emitted into the ambient atmosphere from specific source categories. Sources were categorized as point, area, and mobile. Among the types of sources not included were aircraft operations and marine and rail activities. Table 7 lists the pollutants addressed by the emission inventory.

The bounds of the study area for area and mobile sources were Middlesex (88% of the population) and Union Counties in New Jersey, and Staten Island (Richmond County) in New York. For the point source portion of the inventory, sources in Monmouth, Essex, and Hudson Counties in New Jersey, and in Brooklyn (Kings County) in New York were considered, as well. See Map 2.

Generally, the term "point source" refers to a facility with emissions to the atmosphere from a combination of stacks, exhaust vents, ducts, pipes, or other confined air streams, and from storage tanks. In the 1988 Toxic Chemical Release Inventory (TRI), the facility-wide total also included fugitive emissions; these are emissions not released through readily-identifiable, confined air streams. Fugitives include emissions, evaporation, leakage, or releases from the following sources: blending operations; transfer operations; charging and discharging of reaction vessels; storage piles; leaking seals, pumps, flanges, valves, etc.; furnaces or kilns; open vats or pits; crushing, pelletizing or grinding operations; and loading and unloading operations. While the TRI did serve as the primary data base for emissions estimates, its reporting requirements do not cover all categories of industry, and do exempt facilities with emissions below certain thresholds, facilities with fewer than a specified number of employees, etc.

The point source category covers any facility located in the defined study area and appearing in

- (1) the 1988 TRI;
- (2) the New Jersey Department of Environmental Protection Air Pollution Enforcement Data System (APEDS);

- (3) the New York State Department of Environmental Conservation Source Management System (SMS);
- (4) the New York City Department of Environmental Protection, Bureau of Air Resources Air Management Information System (BARAMIS); and/or
- (5) the EPA Region II/Air Programs Branch POTW Emission Inventory.

The following area source categories originally evaluated under the area source inventory were selected for inclusion as point sources because of the magnitudes of their emissions:

- landfills
- hazardous waste treatment, storage, and disposal facilities (TSDFs)
- publicly-owned treatment works (POTWs)
- hospital sterilizers
- industrial dry cleaners (SIC 7218)

Table 8 is an example of the point source inventory.

The term "area source" applies to stationary sources which are usually too small and/or too numerous to be included singly under the definition of point source. For this project, only the following activities were included under the definition of area source:

- architectural coating
- area (residential) oil heating
- area (residential) wood burning
- auto refinishing [specifically, operations under the Standard Industrial Classification (SIC) 7532 (Prentice Hall, 1988)]
- cold degreasing
- consumer solvent use
- dry cleaning (SIC 7215 - coin operated)
(SIC 7216 - commercial)
- gasoline distribution, retail (SIC 5541)
(i.e. gas tank filling)

Emissions estimates for these area sources were derived from population-based emission factors.

The term "mobile source" applies to motor vehicles which routinely use the roadways, including motorcycles, light-duty gasoline-fueled cars and trucks, light-duty diesel-fueled cars and trucks, medium-duty gasoline and diesel-fueled trucks, heavy-duty gasoline and diesel-fueled trucks, and gasoline and diesel-fueled buses.

Table 9 and Map 3a and 3b are examples of the mobile and area source emissions inventory.

A microinventory is the identification of all stationary sources of air pollution within a defined area around each air monitor. Its purpose is to help explain potential anomalies in monitoring data that may be attributable to the impact of sources close to the monitors, and, thus reflect local air quality rather than project-wide patterns of air quality. For this project, the microinventories were to include all sources within one kilometer (1km = 0.6 mile) of each monitor. In all cases, the microinventories included areas slightly beyond the circle of 1-km radius. The microinventories were conducted by teams that walked and/or drove through every block in the survey area; many area sources not appearing in the aforementioned data bases were identified during the microinventory. Table 10 and Map 4 are samples of the microinventory information.

8. SOURCE IDENTIFICATION

Measured air quality data at the monitoring sites were related to potential sources through the use of meteorological data and meteorological models.

A pollutant rose model was used in assessing long-term air toxics transport patterns, while a surface trajectory model was used to evaluate short-term or episodic periods.

Data inputs to the pollutant rose model consisted of air quality data and wind direction data for the period October 1987 through September 1989. The air quality data represented 24-hour average concentrations for the pollutant sampled on an every-sixth-day basis. For these sampling periods, 24-hour resultant concentration vectors were calculated using wind direction data reduced to the eight compass point classification system: N, NE, E, SE, S, SW, W, NW. The wind direction data, obtained from Newark International Airport, were 3-hour averages; a 24-hour average wind direction was computed from the eight 3-hour averages in the 24-hour period, and paired with the 24-hour average concentration data. Figure 5 is an example of a pollutant rose.

For project sites that were repeatedly among the three or four with the highest concentrations for a given VOC over the two-year course of the ambient air monitoring, pollutant roses were prepared with the goal of developing associations between site concentrations and source areas of the pollutants (source-receptor relationships). A list of the sites and pollutants chosen as subjects for the source identification portion of the pollutant rose analyses follows.

<u>Pollutant</u>	<u>Sites</u>
benzene (year 1)	Dongan Hills Elizabeth Port Richmond Eltingville Carteret Bayley Seton
benzene (year 2)	same as benzene (year 1)
toluene (year 1)	same as benzene (year 1)
toluene (year 2)	same as benzene (year 1)
trichloroethane	Port Richmond Elizabeth Carteret Sewaren Dongan Hills
dichloromethane	Port Richmond Travis
chloroform	Port Richmond Travis
carbon tetrachloride	Elizabeth Carteret Tottenville Sewaren
trichloroethylene	Port Richmond Travis Elizabeth Carteret

Figure 6a is a key to Figure 6b, which is an example of source identification using pollutant roses.

A surface trajectory model was used to depict movement of atmospheric packets or parcels of air backward in time for a given 24-hour sampling period and parcel terminal point. This is accomplished by using surface wind speeds and directions from several nearby meteorological stations. Figures 8, 9, and 10 are examples of surface trajectories resulting, respectively, from 24-hour periods of variable wind speed and direction, winds from one general direction, and stagnation.

For source identification using surface trajectory analysis, sites that exhibited very high concentrations of the pollutant of interest on at least one occasion were chosen, and trajectories were run for the dates in question. Thus, the trajectory analysis was used to associate a peak daily concentration with a source area; while the pollutant rose was used to associate a high annual average with a source direction.

Many sources and source areas may have gone undetected in these analyses due to the variable nature of meteorology and the limited nature of the air toxics sampling program used for the project. The limitations of the emission inventory, as well, affect the source identification results. The following features

of the inventory were of particular importance in assessing relative source contributions: (1) the unavailability of emission factors for many chemicals expected to be emitted from Fresh Kills Landfill, (2) the method-dependence of the mobile source emissions estimates, and (3) the lack of pollutant-specific emissions for many microinventory sources closest to the monitors.

9. RESULTS

- Concentrations of the VOCs were rather uniform among the sites. No single monitoring site was consistently associated with the highest concentrations. A statistical analysis across all sites showed that annual average concentrations could be used to estimate risks for the project, but that the differences between concentrations at the sites were not statistically significant when comparing all sites simultaneously, except in the following cases: tetrachloroethene (tetrachloroethylene, perchloroethylene, a common dry-cleaning solvent), which was statistically significantly higher at the Dongan Hills site than at the five other sites in the comparison; and toluene and o-xylene, which were statistically significantly lower at the Susan Wagner High School site than at the seven and five other sites, respectively, in the comparison. The statistical analysis was necessary for comparison of the reported concentrations since samples were collected and analyzed by different organizations and analytical laboratories, each with its own set of methods, precisions, and accuracies for each pollutant quantitated.
- For chemicals included in the quantitative risk assessment, the annual average concentrations for the SI/NJ UATAP sites were generally in the same concentration ranges as those for other urban areas nationwide, a conclusion based on comparison to the results of the 1988 and 1989 EPA Urban Air Toxics Monitoring Program (UATMP). For chromium, nickel, cadmium, and vanadium, concentrations in the study area were generally higher than at the UATMP sites.
- Local area sources--two dry cleaners and a pumping station of a publicly-owned treatment works (POTW)--appeared to be responsible for the relatively high annual average concentrations of tetrachloroethene at the Dongan Hills and the Staten Island Mall (also called the Pump Station) sites.
- Mobile sources (automobiles and trucks), refineries, and, to some extent, gasoline stations were found to be the major contributors to the highest concentrations of benzene at the

project monitors. The case for toluene was similar, but with some input from other industrial sources and from POTWs. POTWs, industrial sources, and area sources (dry cleaners) were the primary contributors to the highest concentrations of chlorinated hydrocarbons at the project monitors. See Table 11.

The analyses demonstrate that location of a small potential source close to a monitor can greatly affect concentrations measured at that monitor. The emissions inventory was not detailed enough to more than suggest associations between such local sources as gasoline stations and landfills and high concentrations of certain chemicals.

- A limited study of indoor air showed that concentrations of 13 VOCs in four houses in the study area were generally similar to concentrations found in several other data bases for indoor air. Concentrations of eight of the VOCs, including toluene and benzene, were usually higher indoors than outdoors.
- The estimated cancer and noncancer toxicity risks associated with benzene were consistently higher than those estimated for the other pollutants addressed in the risk assessments. The next highest estimated risks for ambient air exposure were associated with nickel, chromium, arsenic, and tetrachloromethane.
- An additive risk assessment for noncancer toxicity by target organ and for cancer from all pollutants combined was conducted. It assumed continuous lifetime exposure to the median annual average ambient air concentrations of the 9 VOCs, 9 metals, benzo[α]pyrene, and formaldehyde monitored during the year October 1988 through September 1989.

The additive risk assessment yielded a maximum hazard index (HI) of 2 for noncancer toxicity; the effects were blood formation (hematopoietic) problems and respiratory tract irritation. (A hazard index is a ratio that is used to characterize the likelihood of adverse noncancer health effects; the higher the number, the greater the concern.)

The cumulative cancer risk estimate was 96 or 123 per million, depending on the assumption concerning the ambient air concentrations of chromium VI.

Tables 12 and 13 provide the results of the additive risk assessment.

A list of sources of uncertainty and limitations in approach affecting the additive risk assessment follows:

1. The noncancer and cancer risk characterizations presented are based on the assumption that the annual average concentration derived from one year of monitoring data reflects an individual's exposure to a given pollutant at a site for a 70-year period. Since emissions and, hence, air quality vary from year to year, and since the amount and direction of variation is unknown, it is unclear how much this assumption affects the calculated risks.

For example, auto usage or fuels may change, and few plants in the area will operate or emit air pollutants at the same levels for 70 years, though the area in which they are located may remain industrial. Thus, future exposures could be lower or higher than the SI/NJ UATAP monitoring data indicate. The controls mandated by the Clean Air Act Amendments of 1990 should continue to lower the concentrations of many of the pollutants measured in this study. Future pollutant exposures and risks will be lower than risks based on 1988-1989 concentration data if the control steps actually do lower the airborne concentrations, and if these reductions are not offset by future growth.

In addition, these risk assessments do not address the consequences of short-term peak exposures (e.g., as a result of periodic releases from point sources) to concentrations higher than the annual average concentrations. The risk assessment for such exposures would require the use of health effect dose-response estimates tailored to the particular exposure assessment, and concentration data focusing on peak concentrations.

2. The calculated excess risks assume continuous outdoor exposure, without addressing the potential exposures from indoor environments in which many people in this country spend much of their time. Indoor concentrations of certain pollutants (e.g., formaldehyde and several VOCs) are commonly several times higher than outdoor concentrations. Thus, risk estimates based on outdoor air concentrations alone may underestimate the contribution of such pollutants to total risk. In contrast, for a pollutant with incomplete penetration into the indoor environment from outdoor sources and no indoor sources, risk estimates based on outdoor air concentrations alone may lead to a higher estimate of the contribution of such pollutants to total risk.
3. The analyses assume that people are continuously exposed to air toxics at the average levels measured at the monitoring station. This assumption does not consider such exposure variables as movement within the urban area, and vacationing, working, or moving outside of the area, any of which could result in risks that are higher or lower than estimated, depending on whether air pollutant concentrations

in the other locations are higher or lower than in the study area.

4. In developing linearized unit risk factors, EPA uses a non-threshold linearized multistage model, which is linear at low doses, to extrapolate from high-dose experimental data to the low doses typically caused by exposure to ambient air pollutants. In other words, carcinogenic substances are assumed to cause some risk at any exposure level. If the true dose-response relationship at low doses is less than linear (e.g., has a threshold), then the unit risk estimates based on EPA Inhalation Unit Risk Factors (IURFs) would tend to be high, and therefore overestimate the risk.

The unit risk factor is based on the upper bound of a 95% confidence interval; if the true unit risk values are less than that upper bound, then the risks calculated in the study might be overestimates.

5. The cancer Weight of Evidence, IURFs, and reference concentrations reflect the current state of toxicological knowledge for specific chemicals. As more scientific information is acquired, these values could change significantly, as they have in the past, and thus the magnitudes and relative contribution of particular pollutants to estimated risk can change. The result is a degree of uncertainty that cannot be assessed.
6. The risk estimates presented do not address the potential for the ambient air mixture of pollutants to exhibit biological activity that is synergistic, or antagonistic relative to their individual effects.
7. The pollutants monitored do not include all pollutants present in ambient air.
8. The amount of chromium VI in the measured total chromium samples, and the identity of the compounds contributing the chromium VI and nickel are information gaps affecting risk estimates that comprise a large portion of the additive risk for the study. Issues related to this uncertainty are discussed in Section 1.4.3 of Volume V of the project report.
9. Particles collected were ≤ 50 microns in aerodynamic diameter, a size range that includes particles larger than the 10-micron aerodynamic diameter considered the upper end of the respirable-size range. Thus, risk estimates driven by the concentration of respirable-size particles may be overestimates.

10. Errors or limitations in the reported concentrations affect the reliability of the risk estimates. The direction of the impact on the risk estimate varies with the chemical. Discussions of data quality are found in Volume III, Parts A and B. Note the following:

Chemical analytical standards for accuracy were not run for mercury at Carteret, Elizabeth, and Highland Park; and for arsenic at Susan Wagner High School (SW) and PS-26.

The analytical recovery of BaP was poor for samples at SW and PS-26 to the extent that the reported BaP concentrations at these sites should be regarded as minimum values. The recovery of nickel from samples at these same sites was 75%.

An ozone interference with the formaldehyde collection method used in the ambient air portion of this project resulted in the reporting of formaldehyde concentrations as less than actual; no correction based on ozone concentration is available.

The availability of concentration data for a chemical at some sites but not others indicates that the omitted data did not meet sampling and/or analysis data quality objectives for the project, or that quantitation of that chemical was not performed by the analytical lab(s) connected with the site(s).

11. The median concentrations used for the particulates and formaldehyde in general, and especially for chromium, may not equitably represent concentrations in the entire study area due to the limited monitoring network for those chemicals, and uneven availability of data at the various sites.

For certain of the VOCs, statistically significant intersite differences in concentration were found; however, with the possible exception of tetrachloroethene, these VOCs provided only small contributions to the additive risk assessment.

12. In evaluating the non-carcinogen HI, it is important to note that the level of concern does not increase linearly as the reference concentration is approached or exceeded because the reference concentrations are not of equal accuracy or precision, and are not based on the same severity of effect.
13. Reference concentrations for the individual chemicals were derived using different methods (available no observed adverse effect level, extrapolation from oral reference dose to inhalation reference concentration, etc.) that include different uncertainty adjustments and modifying factors, adding an additional level of uncertainty associated with

the HI. However, two chemicals contributed most to the HI for respiratory track irritation; and only one contributed to the HI for hematopoietic effects.

14. IURFs are based on carcinogen slope factors that are an upper 95th percentile estimate of potency. Since upper 95th percentiles of probability distributions are not strictly additive, the total additive cancer risk estimate might become artificially more conservative as risks from a number of different carcinogens are summed.
15. While the carcinogens that were analyzed had different Weights of Evidence for human carcinogenicity, the cancer risk equation summed all carcinogens equally, giving as much weight to Group B or C as to Group A carcinogens.
16. The actions of two different carcinogens might not be independent; they might exhibit synergistic or antagonistic effects. This toxicological effect could not be accommodated in this analysis.

10. CONCLUSIONS

In characterizing air quality in Staten Island, this study has provided some perspective of air pollution in this urban area in comparison to other urban areas, and a baseline against which progress resulting from implementation of the Clean Air Act Amendments of 1990 may be measured.

Conduct of the microinventory led to discovery of potential violations. Because each team included a certified air pollution inspector, the identification of illegal activities allowed for immediate action. In some cases, illegal operations (e.g., an unpermitted rock crushing operation at one site, and open burning at other sites) were encountered and shut down on the spot. In other cases, obvious violations were noted (e.g., large gas stations without Stage I or Stage II vapor recovery systems); or potential violators were noted and the information was passed on to EPA and state enforcement groups.

In cases where source identification efforts suggested associations between high concentrations and certain point sources, appropriate follow-up will be pursued; no immediate abatement action is planned.

Compound-specific monitoring for chromium and nickel would allow refinement of the risk estimates for chromium and nickel.

The results of this project are being used by the U.S. EPA towards fulfilling the mandates of the Urban Area Source Program, §112(k) of Title III of the Clean Air Act Amendments of 1990: to list not less than 30 hazardous air pollutants (HAPs)--pollutants that are or will be listed pursuant to §112(b) of Title III--presenting the greatest threat to public health in the largest number of urban areas; to identify and regulate subject to standards pursuant to §112(d) of Title III the area source categories accounting for 90% or more of the aggregate emissions of each of the 30 identified HAPs and to take specific action to reduce the risks posed by the identified HAPs, including achieving a reduction of not less than 75% in the incidence of cancer attributable to HAPs emitted by stationary sources.

More immediately, the Agency for Toxic Substance and Disease Registry is using the SI/NJ UATAP data in its health screening focusing on the Fresh Kills Landfill in Staten Island.

Further, the data and project report are available for analyses beyond those presented in the project report. The data may be used in support of further source identification if the emission inventory is expanded or otherwise augmented, and for further risk assessment should new toxicological information become available. Notably, the peak concentrations reported have not been addressed by the risk analyses; current risk assessment methodologies for public health address long-term exposures, rather than the short-term exposures concomitant with the intermittent high concentrations referred to as peak concentrations. With development of approaches to risk assessment for repeated (i.e., intermittent periodic) exposure to high concentrations, the project data support further analyses. Indeed, this is a continuing concern for highly industrialized, densely-populated areas such as Staten Island and neighboring areas of New Jersey.

11. ADJUNCT STUDY: CITIZEN'S ODOR COMPLAINT NETWORK

As an adjunct to the SI/NJ UATAP, EPA Region II conducted an odor monitoring study called the Citizen's Odor Complaint Network. In an effort to determine whether or not concentrations of targeted organic compounds increase during odor episodes, EPA issued canisters to six residents of the area during the period October 1989 through August 1990. Participants were asked to collect ambient air samples over a 30-minute period during each odor episode. They were also asked to record such available meteorological parameters as wind speed and direction, the time the sample was collected, the general type of odor which was present, the strength of the odor, and any activity in the neighborhood which might be associated with the chemical concentrations found in the sample. These activities could include fuel oil deliveries, use of gasoline lawn mowers, and vehicles idling for an extended period of time.

The Interstate Sanitation Commission's odor complaint log for the test period showed that in a majority of the 24 instances when samples were collected, odor complaints were received from several citizens in the area. This independently confirms that odors were present when the samplers were activated by the participating resident. The greatest number of responses by any one participant was five, the fewest was two. However, it was not possible to link any odor episodes to specific events. The odors were most frequently described as smelling like garbage or burning garbage and cement mix.

The samples were analyzed for 17 VOCs. The vast majority of concentrations obtained from the odor episode samples were <3.0 ppbv. The maximum concentration during any one odor episode was 19.0 ppbv (toluene). Five chemicals--toluene, *o*- and *m/p*-xylenes, benzene, and ethylbenzene--were found in all samples. Methylene Chloride, tetrachloroethene, and 1,1,1-trichloroethane were frequently found. Table 14 lists maximum concentrations for the 17 chemicals detected in the odor episode samples. The mean concentrations of these chemicals during the odor episodes were similar to those observed during the non-episode periods of the SI/NJ UATAP. However, concentrations of chloroform and chloromethane were about 10 times higher in the odor episode samples than in the non-episode period. Overall those compounds with the highest measured concentrations in the non-episode periods tended to have the highest concentrations during the odor episode periods.

Map 1

SINJ UATAP Monitoring Locations

SITES:

1. Westerleigh
2. Travis (PS-26)
3. Annadale, Eltingville
4. Great Kills
5. Port Richmond
6. Dongan Hills
7. Pumping Station
8. Clifton (Bayley Seton Hospital)
9. Tottenville
- A. Elizabeth
- B. Carteret
- C. Sewaren
- D. Piscataway
- E. Highland Park
10. Rossville

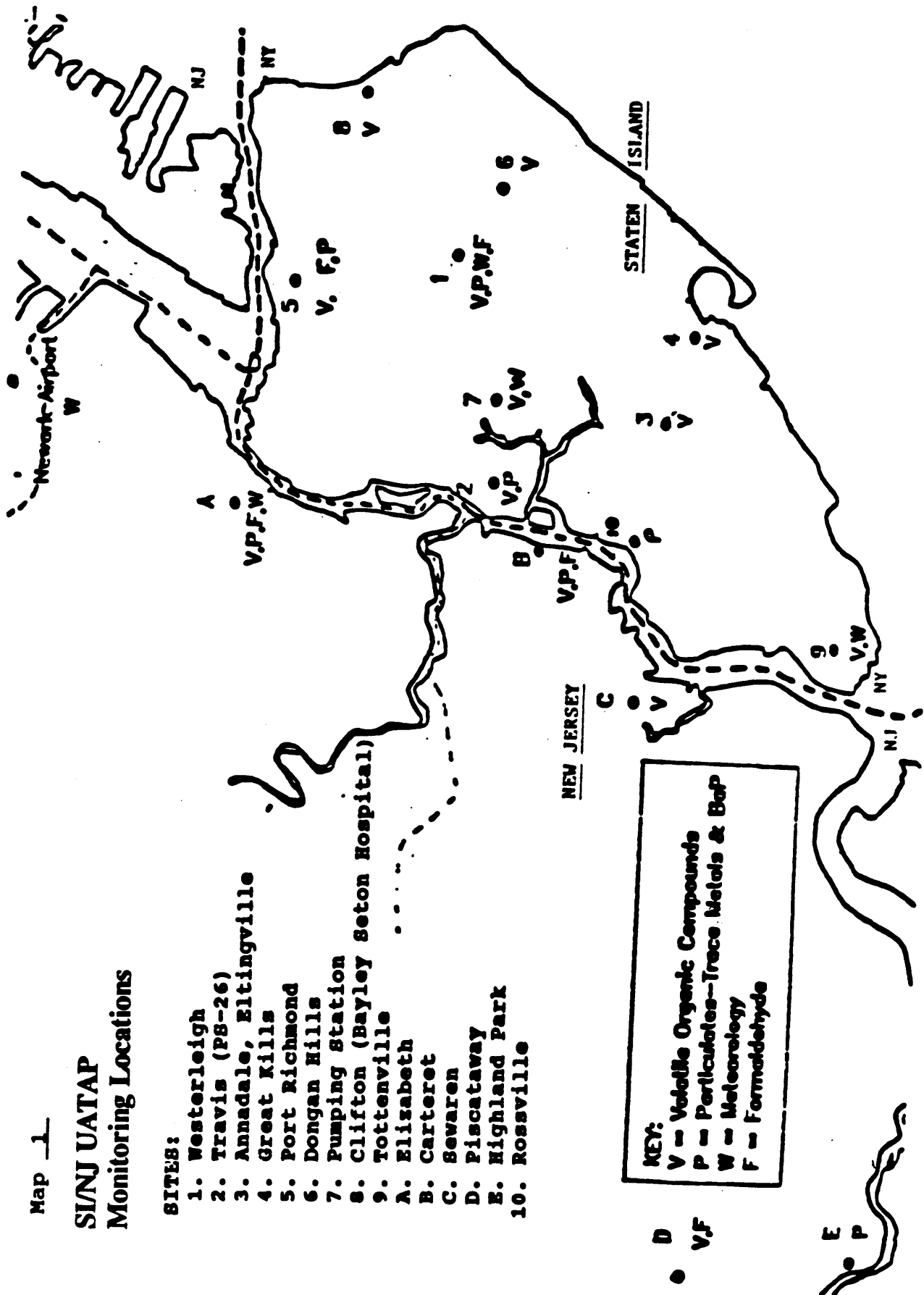


Table 1: Addresses of SI/NJ UATAP ambient air sampling sites

Pumping Station	Across from Staten Island Mall
Carteret Police Department	230 Roosevelt Ave., at Liebig Ave.
Sewaren	PS-28, Matthew Jago H.S., on Sherman Ave. near intersection of Glencove Ave. and Cliff Place
Piscataway	private residence
Susan Wagner H.S.	At Brielle and Manor Streets
PS 26	408 Victory Blvd., near Melvin and Wild Streets
Eltingville Firehouse	Annadale Rd. near Leverett Ave. and Drumgoole Rd.
Elizabeth	Mattano Park near Atlantic and Fifth Ave.
Highland Park	Highland Park Firehouse, 221 S. Fifth Ave., near Mansfield and Graham Streets
Great Kills Firehouse	Nelson Ave. near Presley and Driggs Streets, near Hylan Blvd.
Port Richmond Post Office	Port Richmond Ave. near Hatfield Place and Palmer Ave.
Dongan Hills Firehouse	Richmond Rd. near Seaview Ave. and Four Corners Rd.
Bayley Seton Hospital	Tompkins Ave. at Vanderbilt Ave.
Tottenville Firehouse	Amboy Ave. near Brehaut and Barnard Avenues

Table 2: VOCs Analyzed During Project

Chloromethane¹
Dichloromethane (Methylene Chloride)
Trichloromethane (Chloroform)
Trichloroethane, 1,1,1-
Trichloroethane, 1,1,2-
Tetrachloromethane (Carbon Tetrachloride)
Trichloroethylene
Tetrachloroethylene (Tetracholoroethene, perchloroethylene)
Dichloroethane, 1,1-
Dichloroethane, 1,2- (Ethylene dichloride)
Tribromomethane (Bromoform)
Benzene
Toluene
Hexane
Xylene, o-
Xylene, m- and p- ²
Ethlybenzene
Chlorobenzene
Styrene
Dichlorobenzene, o- (1,2 - dichlorobenzene)
Dichlorobenzene, m- (1,3 - dichlorobenzene)
Dichlorobenzene, p- (1,4 - dichlorobenzene)

¹ No valid data obtained from ambient air monitoring.

² Not separated by analytical method.

Table 3: Particulate Species Analyzed During Project

Arsenic
Barium
Benzo[α]pyrene
Beryllium¹
Cadmium
Chromium
Cobalt
Copper
Iron
Lead
Manganese
Mercury
Molybdenum
Nickel
Selenium²
Vanadium
Zinc

¹ Never detected.

² No valid data were obtained.

Table 4: ANNUAL AVERAGE SUMMARY FOR AN INDIVIDUAL POLLUTANT

O-XYLENE - 1,2-(CH₃)₂C₆H₄ (1,2-DIMETHYL BENZENE)

SITE	SITE #	QUARTER BEGINNING OCTOBER 1987			QUARTER BEGINNING JANUARY 1988			QUARTER BEGINNING APRIL 1988			QUARTER BEGINNING JULY 1988			FIRST YEAR OCT 1987 - SEPT 1988		
		# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES
CARTERET	B	13	0.33	15	0.27	14	0.34	15	0.49	57	0.36	17	0.50			
ELIZABETH	A					3	0.26									
SEVAREN	C															
PISCATAWAY	D															
SUSAN WAGNER HS	1	13	0.33	14	0.33	13	0.20	10	0.27	50	0.28					
PS 26	2	10	0.53	13	0.48	13	0.28	4	0.47	40	0.43					
PORT RICHMOND PO	5	10	0.81	14	0.89	15	0.43	4	0.59	43	0.68					
PUMPING STATION	7															
GREAT KILLS	4															
TOTTENVILLE	9															
BAYLEY SETON HOSPITAL	8	87	0.53	82	0.33	74	0.24	77	0.35	320	0.37					
ELTINGVILLE	3	88	0.61	57	0.42	77	0.25	67	0.30	289	0.40					
DONGAN HILLS	6	86	0.63	55	0.52	77	0.28	66	0.38	284	0.46					

O-XYLENE - 1,2-(CH₃)₂C₆H₄ (1,2-DIMETHYL BENZENE)

SITE	SITE #	QUARTER BEGINNING OCTOBER 1988			QUARTER BEGINNING JANUARY 1989			QUARTER BEGINNING APRIL 1989			QUARTER BEGINNING JULY 1989			SECOND YEAR OCT 1988 - SEPT 1989		
		# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES	ARITH. MEAN (ppb)	# OF SAMPLES
CARTERET	B	15	0.53	11	0.48	13	0.29	14	0.29	53	0.40					
ELIZABETH	A	15	0.52	13	0.45	15	0.26	14	0.34	57	0.40					
SEVAREN	C			10	0.49	12	0.24	14	0.24	36	0.31					
PISCATAWAY	D			13	0.29	15	0.12	14	0.33	42	0.24					
SUSAN WAGNER HS	1	11	0.24	12	0.38	12	0.28	15	0.28	50	0.30					
PS 26	2	13	0.40	13	0.50	13	0.40	15	0.46	54	0.44					
PORT RICHMOND PO	5	11	0.46	13	0.61	12	0.58	15	0.53	51	0.55					
PUMPING STATION	7	11	0.38	13	0.50	13	0.47	15	0.49	52	0.46					
GREAT KILLS	4	11	0.36	12	0.43	12	0.35	15	0.33	50	0.37					
TOTTENVILLE	9	8	0.26	13	0.38	13	0.28	15	0.34	49	0.32					
BAYLEY SETON HOSPITAL	8	83	0.42	84	0.38	8	0.25	19	0.23	194	0.38					
ELTINGVILLE	3	79	0.40	67	0.41	7	0.21	20	0.27	173	0.38					
DONGAN HILLS	6	75	0.53	80	0.56	6	0.28	18	0.25	179	0.51					

TABLE 5: AMBIENT AIR CONCENTRATIONS FOR THE VOLATILE ORGANIC COMPOUNDS*
ANNUAL AVERAGES FOR OCTOBER 1988 THROUGH SEPTEMBER 1989*

CHEMICAL	Concentrations, ppb													
	NEW JERSEY					NEW YORK SITES								
	CART	ELIZ	SEW	PSCAT	HIPRK	SW	PS-26	PRT RCH	PUMP	GT KLLS	TOTT	B-STN	ELTVL	DONGAN
DICHLOROMETHANE	--	--	--	--	-	0.47	0.93	0.85	0.76	0.50	0.60	--	--	--
TRICHLOROMETHANE	0.02	0.02	0.02	0.02	-	0.07	0.10	0.08	0.15	0.06	0.07	0.03	0.04	0.03
TETRACHLOROMETHANE	0.12	0.13	0.15	0.11	-	0.09	0.10	0.09	0.10	0.10	0.16	0.11	0.14	0.12
TRICHLOROETHENE	0.05	0.04	0.04	0.05	-	0.10	0.12	0.13	0.27	0.07	0.08	0.08	0.06	0.07
TETRACHLOROETHENE	0.17	0.21	0.21	0.13	-	0.18	0.19	0.24	1.09	0.20	0.20	0.27	0.21	0.68
HEXANE, n-	1.08	0.91	0.84	0.50	-	-	-	-	-	-	-	0.77	0.89	0.86
BENZENE	1.48	1.45	1.16	0.97	-	0.77	1.27	1.34	1.16	0.92	0.86	1.40	1.50	1.96
TOLUENE	3.80	3.62	2.88	2.11	-	2.42	3.88	4.25	3.87	2.89	2.81	3.19	3.45	4.10
XYLENE, o-	0.40	0.40	0.31	0.24	-	0.30	0.44	0.55	0.46	0.37	0.32	0.37	0.38	0.42
XYLENES, p- and m-	1.16	1.06	0.85	0.52	-	0.92	1.42	1.76	1.50	1.19	1.04	1.83	1.89	2.48
ETHYLBENZENE	-	-	-	-	-	-	-	-	-	-	-	0.50	0.53	0.66

* Only the volatile organic compounds addressed by quantitative risk assessment are included.

$\sum n_i$

* Annual avg. = $\frac{\sum n_i}{\sum n_i}$, where n_i = number of samples in the i th quarter,
 \bar{x}_i = avg. conc. in the i th quarter. Includes annual averages based on ≥ 38 samples.

- Samples not collected at this site.

-- Submitted data not good; inappropriate collection method.

Note: In the absence of accuracy and precision characterization of the reported annual averages, differences should not be assumed to be statistically significant.

CART Carteret ELIZ Elizabeth SEW Seward PSCAT Piscataway HIPRK Highland Park SW Susan Wagner H.S. PS-26 Travis PRT RCH Port Richmond
PUMP Pumping Station GT KILLS Great Kills TOTT Totenville B-STN
Bayley Seton ELTVL Eltingville DONGAN Dongan Hills

TABLE 6: AMBIENT AIR CONCENTRATIONS¹ FOR METALS*, BENZO[*a*]PYRENE, AND FORMALDEHYDE-ANNUAL AVERAGES FOR OCTOBER 1988 THROUGH SEPTEMBER 1989

Chemical	Concentrations, ng/m ³					
	CART	ELIZ	HIPRK	SU	PS-26	PRT RICH
ARSENIC	----	----	----	3.7	4.3	----
CADMIUM	4.2	1.6	2.1	2.4	2.5	----
CHROMIUM, total	27	16	12	----	----	----
LEAD ²	43.1	38.6	91.1	39.5	45.7	----
MANGANESE	21.6	14.8	13.3	15.2	18.8	----
MERCURY	0.5	0.5	0.5	----	----	----
NICKEL	28.2	23.6	22.4	19.1	20.2	----
VANDIUM	----	----	----	15.2	16.9	----
ZINC	116.1	113.9	97.8	113.2	96.3	----
BaP	0.20	0.19	0.14	0.15	0.21	----
FORMALDEHYDE ³	----	----	----	2524 (2.02 ppb)	----	2137 (1.71 ppb)

* Only the metals addressed by quantitative risk assessment are included.
 --- Indicates that no data are available.

¹ $\text{Annual avg.} = \frac{\sum x_i}{n}$, where n = number of samples in the i th quarter,

x_i = avg. conc. in the i th quarter. Includes annual averages based on ≥ 30 samples.

² Highest quarter concentrations, not annual average concentrations.

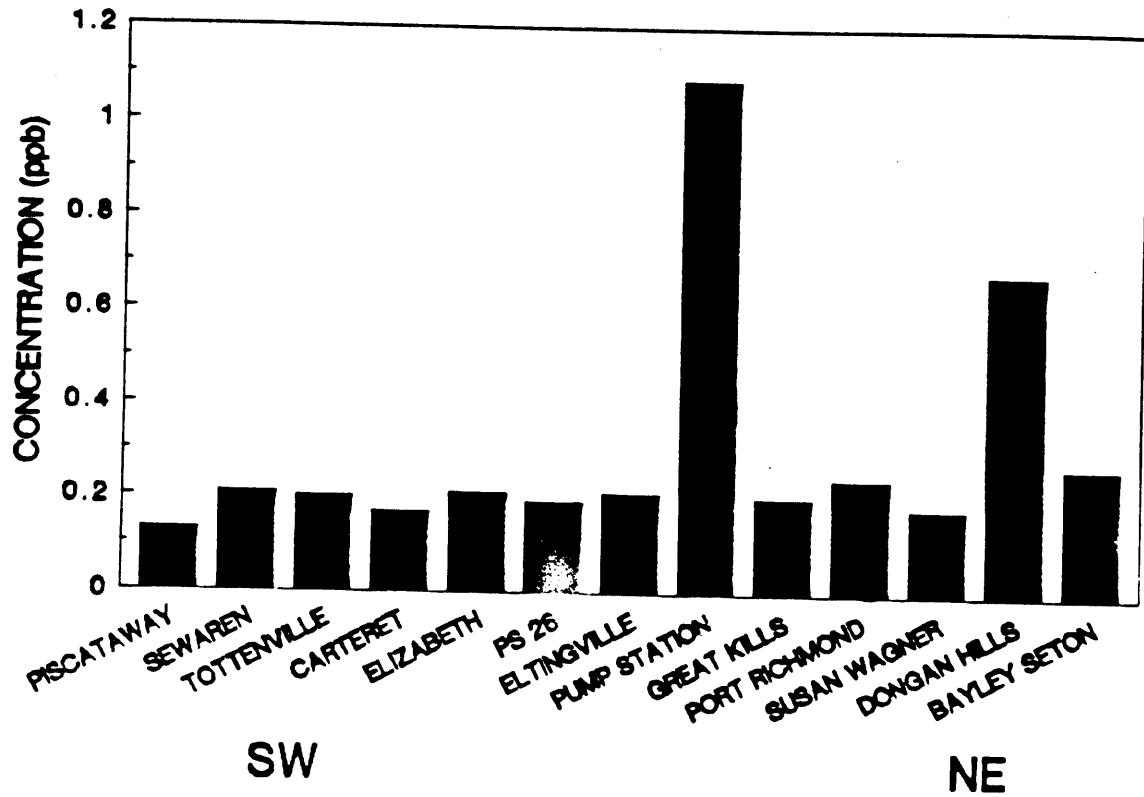
³ Formaldehyde concentrations were converted from ppb to ng/m³ with the following formula (MW, molecular weight, of formaldehyde is 30.03):
 $\text{ng/m}^3 = (\text{ppb})(\text{MW})(1000)/24.04 \text{ l}$, where 24.04 l is volume of ideal gas at 20°C.

CART Carteret ELIZ Elizabeth HIPRK Highland Park SU Susan Wagner PS-26 Travis PRT RICH Port Richmond

Note: Apparent site-to-site differences in concentration may not be statistically significant.

Figure 1

TETRACHLOROETHYLENE 2ND YEAR AVERAGES



MONITORING AGENCY

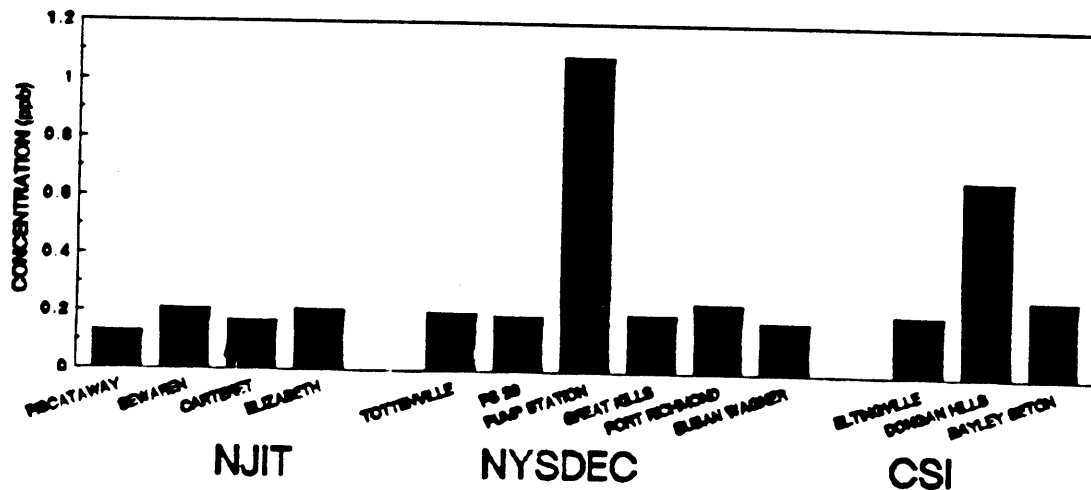
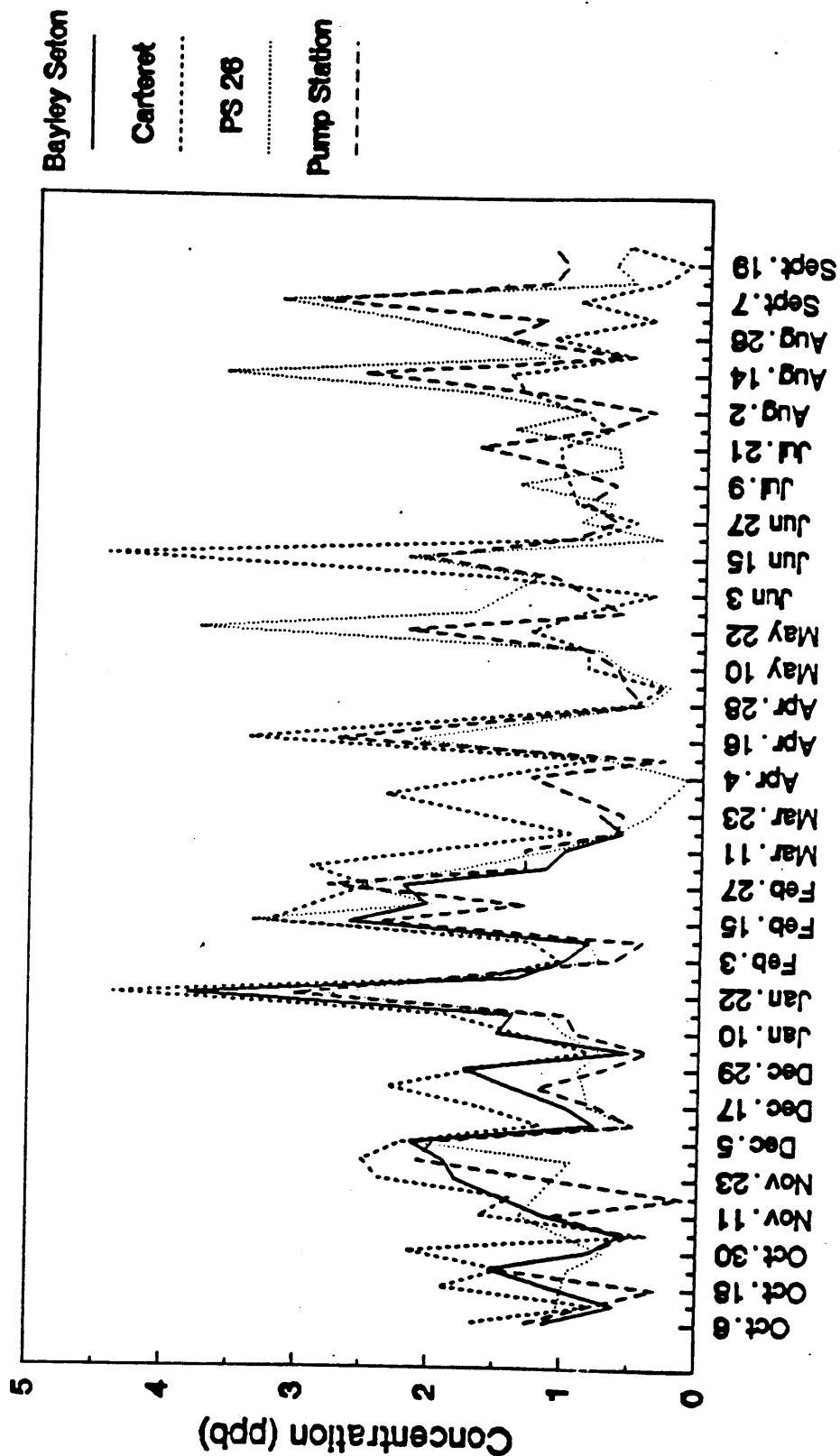


Figure 2

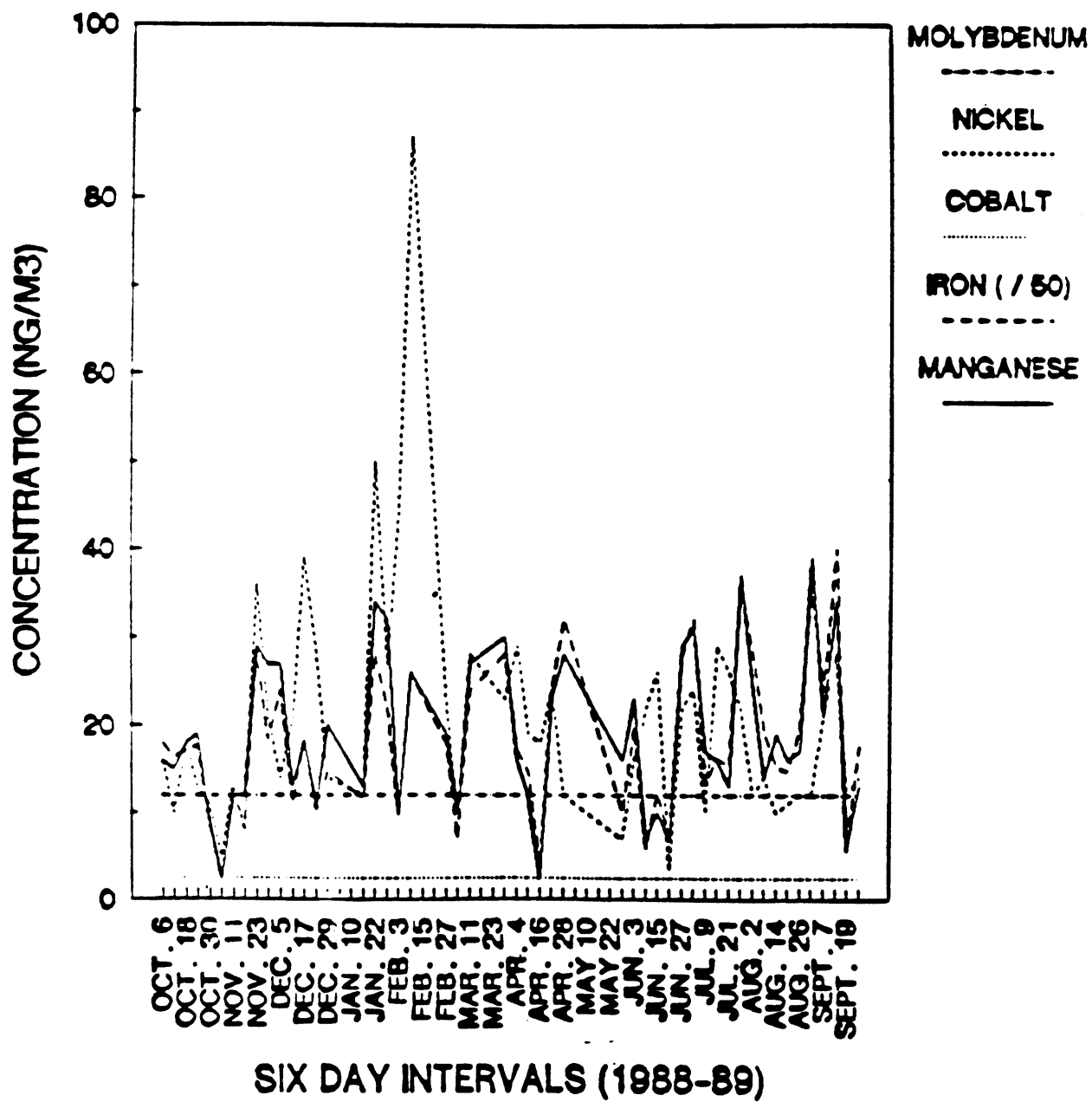
Benzene 4 Sites



Six Day Intervals (1988-89)

Figure 3

**Molybdenum, Nickel, Copper, Iron, and Manganese
at PS-26**



**Comparison of SI/NI UATAP Data (10/88-10/89)
with 1988 UATMP Data (10/87-10/88)**

Site	Annual Average Concentration (ng/cu.m.)
Seattle	22
Alaska GA	22
Baton Rouge LA	2
Birmingham AL	2
Burlington VT	2
Chicago IL	2
Cleveland OH	2
Dallas TX	5
Denver CO	2
Detroit MI	5
Duquoin IL	2
Houston TX	2
Jackson MI	5
Lansing MI	5
Louisville KY	2
Miami FL	38
Norfolk VA	2
Port Haron MI	2
Saginaw MI	2

* Highland Park NJ (SONU UNTAP background site)
 ** Median for Cortland, Elizabeth, PS-28, and Susan Wagner H.S.

Table 1: Chemicals addressed for each category of the emissions inventory

Chemical	Mobile Sources	Area Sources treated as Point Sources			Point Sources	AREA SOURCES							
		POTWs	Landfills	Res. Waste		Area resid. oil heating	Archit. coating	Auto Refinish	Cold degreasing	Area used wood heating	Consumer solvent use	Dry Cleaning	Gasoline distribution & retail
benzene	X	X		X	X				X				X
carbon tetrachloride		X			X								
trichloroethane		X			X								
dichloromethane		X			X				X				
tetrachloroethylene		X	X	X	X				X		X		
toluene	X	X	X	X	X		X	X	X				X
1,1,1-trichloroethane		X			X				X				
trichloroethylene		X		X	X				X				
xylenes	X			X	X		X	X	X				X
p-xylene					X								
m-xylene					X								
p-xylene					X								
n-hexane	X				X								
o-xylene & compounds					X								
formaldehyde	X				X							X	

Map 2: Boundaries for the SI/NJ point and area/mobile source emissions inventories

- Area and mobile sources boundary
- - - Point sources boundary

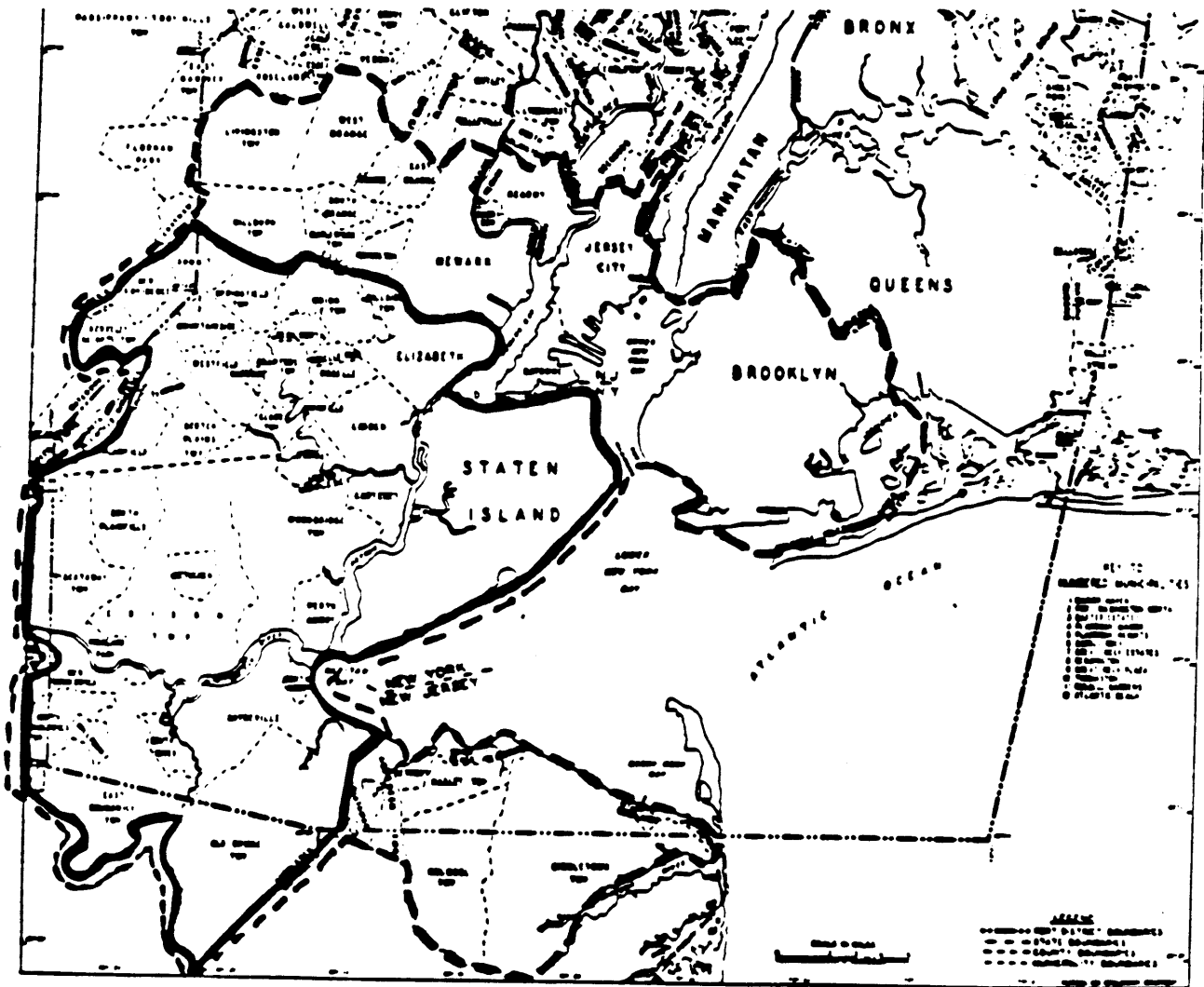


Table 8: Perchloroethylene (tetrachloroethylene) point source inventory (partial listing)

FACILITY NAME	STREET ADDRESS	CITY	ZIP CODE	UTM NORTHING	UTM EASTING	FACILITY-WIDE EMISSIONS ^f (TPY)	ENGINEERING SCIENCE (TPY)	SOURCE ^s	UATAP EMISSIONS INVENTORY (TPY)
I.L.R. SLF		EDISON	08818	4482.0	556.5		0.09	E	0.09
JAMESBURG SCHOOL FOR BOYS POTW				4465.0	552.0		0.39	E	0.39
JOHN B MOORE CORPORATION	ROUTE 9 AT PARKWAY	SAYREVILLE	08872	4481.8	559.4			A	0.01
JOINT MEETING OF ESSEX-UNION POTW	500 SOUTH FIRST STREET	ELIZABETH	07202	4498.4	567.9		198.54	E	198.54
KIN-BUC INC. #1		EDISON TOWNSHIP	08817	4482.5	554.5		0.04	E	0.04
KLEINER METAL SPECIALTIES INC.	4315 NEW BRUNSWICK AVE.	SOUTH PLAINFIELD	07080	4299.0	599.0			A	1.75
KNIGHTS OF COLUMBUS LANDFILL		MONROE TOWNSHIP		4468.0	548.0		0.01	E	0.01
LINDEN CITY SLF		LINDEN	07036	4494.5	564.0		0.02	E	0.02
LINDEN ROSELLE POTW	5005 SOUTH WOOD AVE	LINDEN	07036	4495.0	567.1		31.71	E	31.71
LIMPRO COMPANY POTW, THE				4464.0	533.2		1.96	E	1.96
LOTAMO LANDFILL		EDISON TOWNSHIP	08817	4494.5	553.5		0.01	E	0.01
MARISOL INC.	125 FACTORY LANE	MIDDLESEX	08846	4489.9	540.9		0.25	E	0.25
MIDDLESEX COUNTY POTW 1	CHEVALIER AVE	SAYREVILLE	08872	4481.0	563.3	5.81	244.63	E P	5.81
MIDDLESEX COUNTY POTW 2				4483.0	550.8	23.11	0.18	E P	23.11
MOHAWK LABORATORIES OF NJ	STOUTS LANE	MONMOUTH JUNCTION	08852	4469.8	536.5	0.44		A	0.44
NATIONAL LEAD LANDFILL		PERTH AMBOY	08861	4486.0	562.5		0.01	E	0.01
NL INDUSTRIES INC. SLF		SAYREVILLE	08872	4483.0	559.0		1.01	E	1.01
OLD BRIDGE MUA BROWNTOWN POTW				4472.1	558.8		2.67	E P	0.24
OLD BRIDGE POTW	OLD WATER WORKS ROAD	ELIZABETH	08857	4478.6	564.9	0.24	0.03	E	0.03
PERK CHEMICAL CO., INC		PLAINSBORO TOWNSHIP	07207	4499.8	568.5		0.01	E	0.01
PLAINSBORO TWP. SLF EXPANSION			08536	4463.5	535.0		0.01	E	0.01
P.D. OIL & CHEMICAL STORAGE, INC.	FOOT OF EAST 22ND STREET	BAYONNE	07002	4500.9	575.9		0.01	E	0.01
RAHWAY VALLEY SA POTW	1050 EAST HAZELWOOD AVE	RAHWAY	07065	4492.8	569.9	8.10	80.56	E P	3.69
ROSS FRANK B CO INC	6-10 ASH STREET	JERSEY CITY	07304	4506.8	579.3			A	8.10
SAYREVILLE BORO SLF		SAYREVILLE	08872	4477.0	554.0		0.01	E	0.01
SOLVENTS RECOVERY SERVICE OF M		LINDEN	07036	4496.0	563.2		0.19	E	0.19
SOMERSET-RARITAN VALLEY POTW	POLHEMUS AVE	BRIDGEWATER	08807	4489.0	536.6	0.07	0.01	E	0.07
SOUTH AMBOY CITY LANDFILL		SOUTH AMBOY	08879	4483.0	559.5		2.91	E	2.91
SOUTH AMBOY POTW		SOUTH AMBOY	08879	4481.0	560.0			A	0.11
SOUTH BRUNSWICK TOWNSHIP	RT 522 & DAYTON-JAMESBURG RD	SOUTH BRUNSWICK	08810	4469.0	541.8	0.11	0.01	E	0.01
SOUTH BRUNSWICK TWP. SLF				4469.0	538.5		0.02	E	0.02
SOUTH PLAINFIELD BORO		SOUTH PLAINFIELD	07080	4490.5	550.5			E	

¹ "ND" means no data from which air emissions may be estimated.

^A APEDS 12/28/89 - permit allowable annual emissions rate (rounded to one-hundredths of a ton).

^f FACILITY WIDE EMISSIONS means data from TRI (SARA 313), the NYSDEC Source Management System (SMS), or the EPA Region II POTW Inventory.

^s SOURCE LEGEND: A = APEDS; E = Engineering Science Inventory; P = EPA Region II POTW Inventory; S = SMS; T = TRI.

TABLE 9: Mapping values (shading) for the area and mobile source emissions density maps (partial listing)
Mapping values, ranges in tons/year: 0 = 0, 1 = ≤5, 2 = >5 to ≤10, 3 = >10 to ≤15, 4 = >15 to ≤20, 5 = >20 to ≤30, 6 = >30

Staten Island Cells	NJ												
	UTM-N	UTM-E	BENZENE	BENVAL ¹	METHOD ²	CADMIUM	CADVAL	FORMAL-DEHYDE	FORMVAL	DICHLORO-METHANE	DCMVAL	PERCHLORO-ETHYLENE	PERCVAL
1.00	4481.00	565.00	3.13	1	1	0.000	0	0.688	1	0.037	1	0.402	1
2.00	4483.00	565.00	3.23	1	1	0.001	1	0.721	1	0.097	1	1.058	1
3.00	4485.00	565.00	0.00	0	1	0.000	0	0.000	0	0.000	0	0.000	0
4.00	4487.00	565.00	0.00	0	0	0.000	0	0.000	0	0.000	0	0.000	0
5.00	4481.00	567.00	0.56	1	1	0.000	0	0.133	1	0.068	1	0.737	1
6.00	4483.00	567.00	7.10	2	1	0.001	1	1.580	1	0.179	1	1.950	1
7.00	4485.00	567.00	21.67	5	1	0.001	1	4.740	1	0.068	1	0.735	1
8.00	4487.00	567.00	5.55	2	1	0.000	0	1.218	1	0.041	1	0.442	1
9.00	4481.00	569.00	0.00	0	1	0.000	0	0.001	1	0.001	1	0.014	1
10.00	4483.00	569.00	5.14	2	1	0.001	1	1.138	1	0.091	1	0.992	1
11.00	4485.00	569.00	18.00	4	2	0.003	1	3.985	1	0.342	1	3.718	1
12.00	4487.00	569.00	19.55	4	1	0.001	1	4.282	1	0.104	1	1.132	1
13.00	4489.00	569.00	4.09	1	0	0.000	0	0.893	1	0.000	0	0.000	0
14.00	4491.00	569.00	1.01	1	0	0.000	0	0.220	1	0.000	0	0.000	0
15.00	4493.00	569.00	0.00	0	0	0.000	0	0.000	0	0.000	0	0.000	0
16.00	4495.00	569.00	0.00	0	0	0.000	0	0.000	0	0.000	0	0.000	0
17.00	4497.00	569.00	0.00	0	0	0.000	0	0.000	0	0.000	0	0.000	0
18.00	4483.00	571.00	1.86	1	1	0.000	0	0.417	1	0.070	1	0.756	1
19.00	4485.00	571.00	13.88	3	2	0.003	1	3.088	1	0.349	1	3.789	1
20.00	4487.00	571.00	14.42	3	4	0.005	1	3.285	1	0.805	1	8.746	2
21.00	4489.00	571.00	6.37	2	1	0.001	1	1.404	1	0.075	1	0.813	1
22.00	4491.00	571.00	15.12	4	2	0.002	1	3.345	1	0.270	1	2.931	1
23.00	4493.00	571.00	23.11	5	1	0.001	1	5.049	2	0.039	1	0.419	1
24.00	4495.00	571.00	22.56	5	1	0.001	1	4.921	1	0.004	1	0.039	1
25.00	4497.00	571.00	10.67	3	1	0.001	1	2.331	1	0.013	1	0.137	1
26.00	4485.00	573.00	8.53	2	3	0.003	1	1.952	1	0.534	1	5.798	2
27.00	4487.00	573.00	9.78	2	4	0.006	1	2.312	1	1.046	1	11.365	3
28.00	4489.00	573.00	5.92	2	1	0.002	1	1.334	1	0.241	1	2.620	1
29.00	4491.00	573.00	5.50	2	2	0.002	1	1.265	1	0.377	1	4.099	1
30.00	4493.00	573.00	16.96	4	2	0.004	1	3.788	1	0.507	1	5.504	2
31.00	4495.00	573.00	21.58	5	3	0.005	1	4.821	1	0.661	1	7.184	2
32.00	4497.00	573.00	3.38	1	2	0.002	1	0.797	1	0.344	1	3.734	1
33.00	4485.00	575.00	2.05	1	1	0.001	1	0.460	1	0.079	1	0.861	1
34.00	4487.00	575.00	6.72	2	3	0.004	1	1.581	1	0.667	1	7.247	2

¹ "BENVAL" (also CADVAL, FORMVAL, DCMVAL and PERCVAL) means the mapping value applied to each grid cell, which corresponds to the emissions density range (in tons per year).

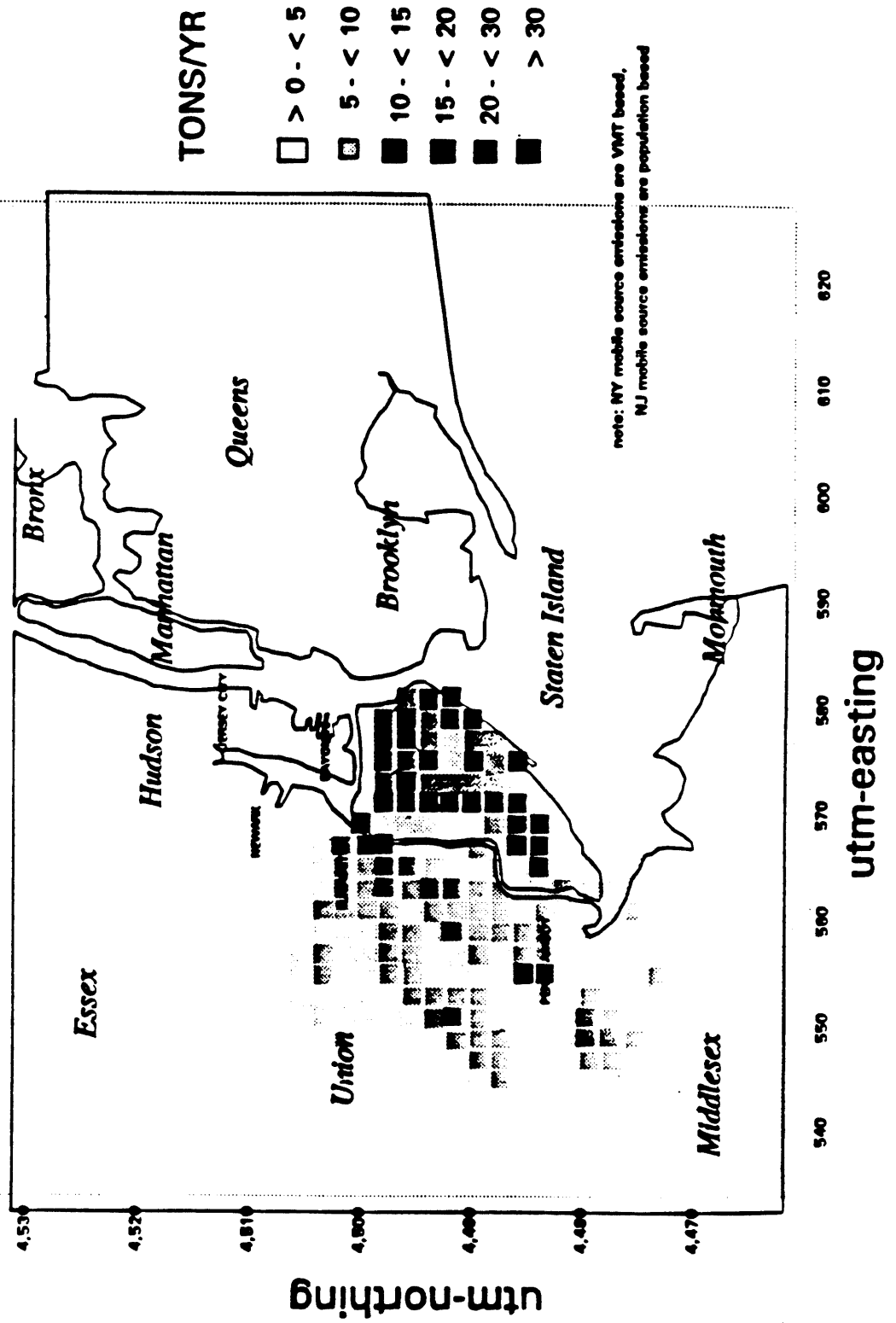
² "NJ METHOD BENVAL" is the population-based value for comparison with the NY VMT-based value generated for the Staten Island grid cells only.

³ FACILITY WIDE EMISSIONS means data from TRI (SARA 313), the NYSDEC Source Management System (SMS), or the EPA Region II POTW Inventory.

⁴ SOURCE LEGEND: A = APEDS; E = Engineering Science Inventory; P = EPA Region II POTW Inventory; S = SMS; T = TRI.

Map 3a

STATEN ISLAND PROJECT MAPPING SYSTEM BENZENE AREA & MOBILE SOURCE EMISSION DENSITIES



STATEN ISLAND PROJECT MAPPING SYSTEM BENZENE AREA & MOBILE SOURCE EMISSION DENSITIES

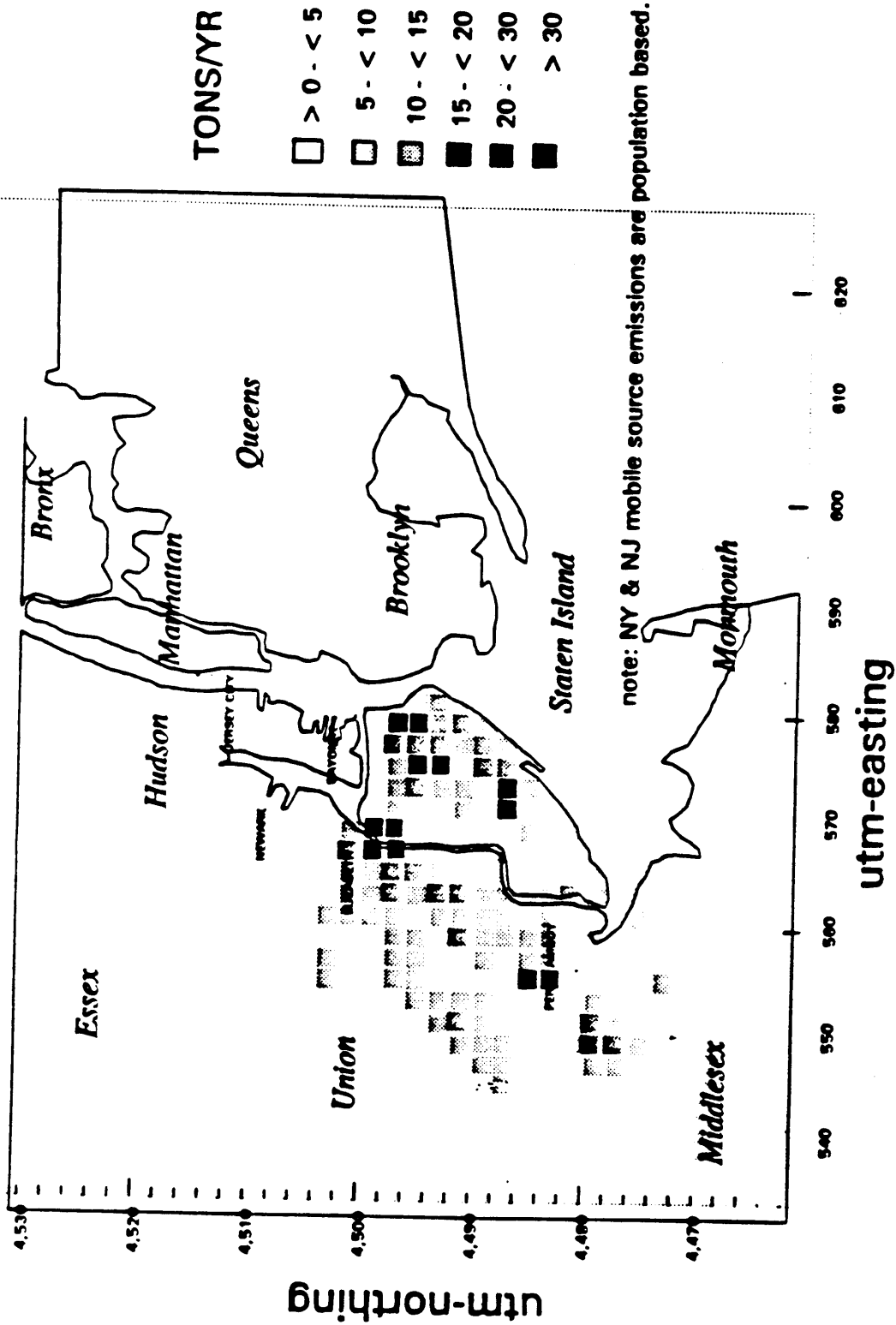


Table 10 : Major and minor sources identified at Dongan Hills microinventory site.

DONGAN HILLS SITE, STATEN ISLAND

NO.	NAME	ADDRESS	TYPE	INVEN	PM	VOC
701	GETTY STATION	1201 VICTORY BLVD.	GAS STATION	SMS	0.00	1.39
702	IMPERIAL CLEANERS	RICHMOND & JEFFERSON AVE.	DRY CLEANERS	--	N.A.	N.A.
703	E & M MOBILE STATION	2150 NYLAN BLVD	GAS STATION	SMS	0.00	7.46
704	IS 2	BOUNDARY & MIDLAND	SCHOOL BOILER	--	N.A.	N.A.
705	OCTANE PLUS	NYLAN & JEFFERSON	GAS STATION	--	N.A.	N.A.
706	CITGO STATION	NYLAN & SLATER AVE.	GAS STATION	--	N.A.	N.A.
707	BOULEVARD CLEANERS	NYLAN & NAUGHTON AVE.	DRY CLEANERS	SMS	0.00	3.24
708	REVERE CLEANERS	NYLAN & GARRETSON AVE.	DRY CLEANERS	--	N.A.	N.A.
709	BP STATION	NYLAN & ALLEN AVE.	GAS STATION	--	N.A.	N.A.
710	AMOCO STATION	1581 NYLAN BLVD.	GAS STATION	SMS	0.00	3.15
711	MERCURY CLEANERS	1501 NYLAN BLVD.	DRY CLEANERS	SMS	0.00	4.86
712	GETTY STATION	NYLAN & COOPER AV.	GAS STATION	--	N.A.	N.A.
713	GULF STATION	NYLAN & REID AV.	GAS STATION	--	N.A.	N.A.
714	TODT HILL CLEANERS	NYLAN & OLD TOWN RD.	DRY CLEANERS	--	N.A.	N.A.
715	SEAFER CLEANERS & FRENCH TAILORS	NYLAN & SEAFER AVE.	DRY CLEANERS	--	N.A.	N.A.
716	EAGLE GAS	NYLAN & WANDEN AVE.	GAS STATION	--	N.A.	N.A.
717	GASETERIA	NYLAN & WANDEN AVE.	GAS STATION	--	N.A.	N.A.
718	SUNOCO STATION	2200 NYLAN BLVD.	GAS STATION	SMS	0.00	3.60
719	R & J SERVICE STATION	NYLAN & LINCOLN AVE.	GAS STATIONS	--	N.A.	N.A.
720	VINCENT'S FRENCH CLEANERS	LINCOLN AVE.	DRY CLEANERS	--	N.A.	N.A.
721	PS 11	JEFFERSON & GARRETSON AVE.	SCHOOL BOILER	--	N.A.	N.A.
722	MICHAEL'S CLEANERS	RICHMOND & SEAVIEW AVE.	DRY CLEANERS	--	N.A.	N.A.
723	ONE-STOP CLEANERS	RICHMOND & SEAVIEW AVE.	DRY CLEANERS	--	N.A.	N.A.
724	MOBIL OIL CORP.	1600 RICHMOND AVE.	GAS STATION	SMS	0.00	2.05
725	MORA'S CLEANERS	RICHMOND & BUEL AVE.	DRY CLEANERS	--	N.A.	N.A.
726	REVERE CLEANERS	NYLAN & GARRETSON AVE.	DRY CLEANERS	--	N.A.	N.A.
727	BP STATION	RICHMOND & DELWOOD AVE.	GAS STATION	--	N.A.	N.A.

Site Summary

This site is very residential with two major commercial areas along Nylan Blvd. and Richmond Avenue.

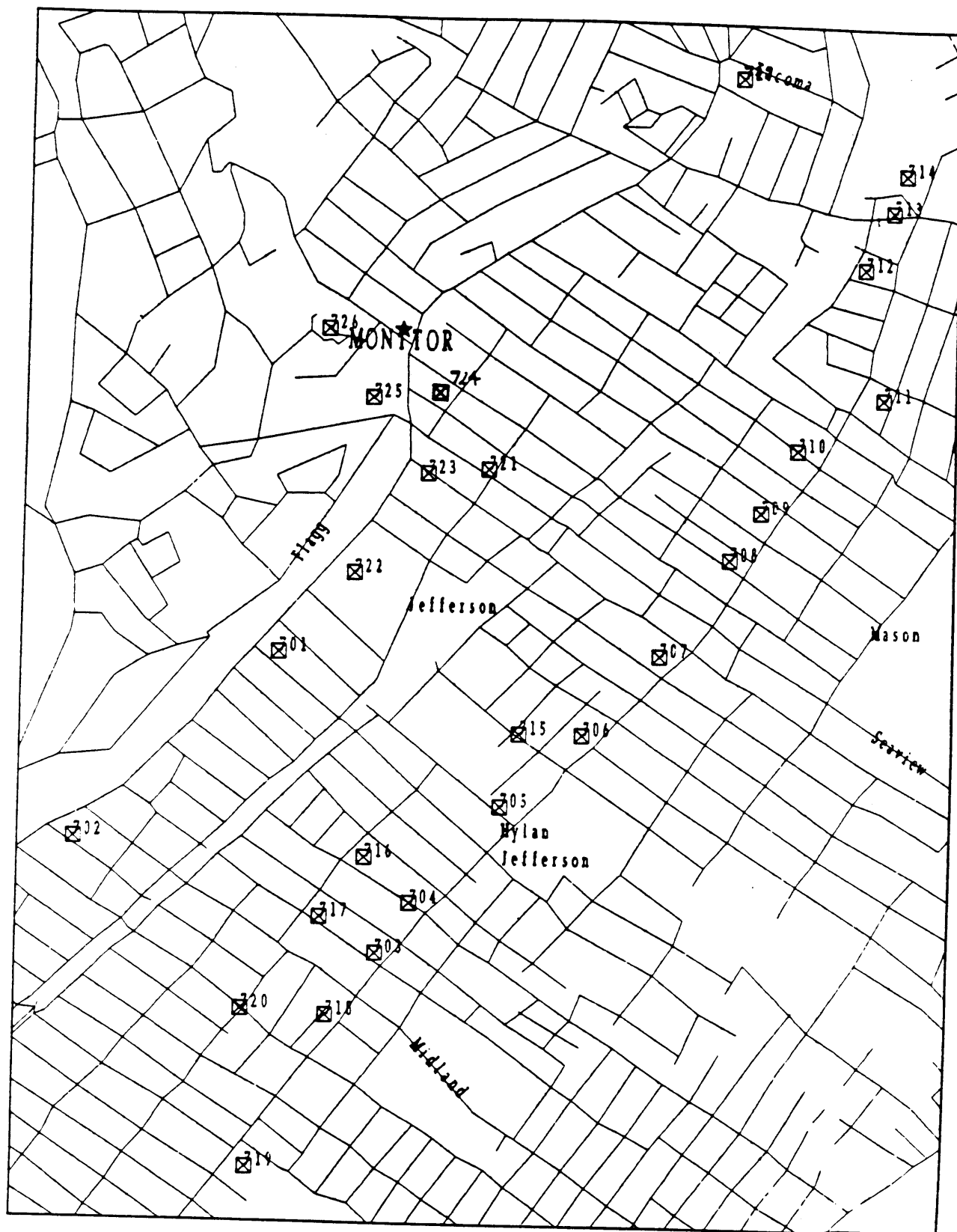
MAJOR SOURCES:

There were no major sources in the area.

MINOR SOURCES:

There were 27 minor sources that were located during the microinventory. The breakdown is as follows:

- 14 gas stations
- 11 dry cleaners
- two school boilers



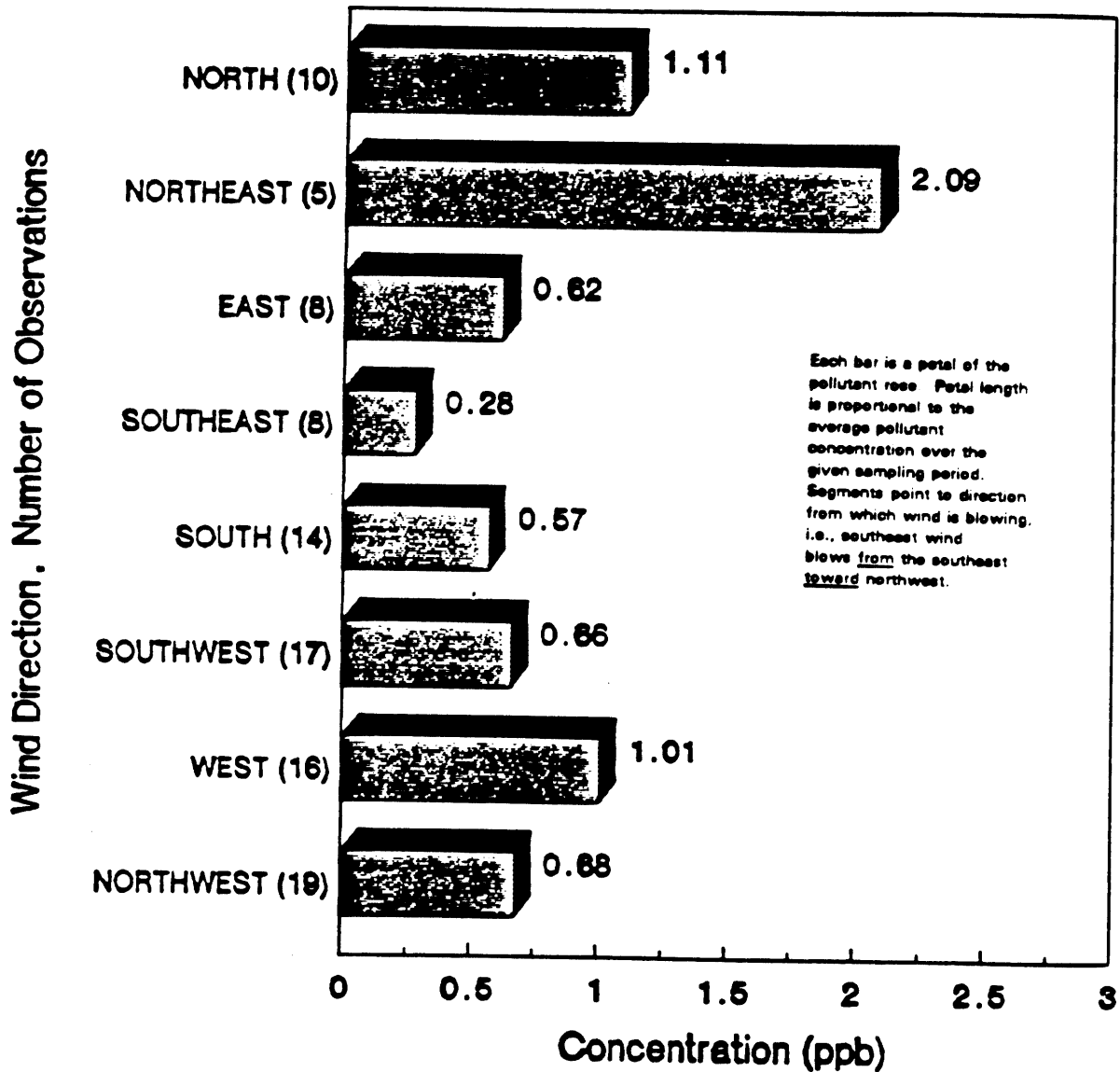
Map 4 . Dongan Hills, NY microinventory site.

Figure 5

SI/NJ UATAP POLLUTANT "ROSE"

PORT RICHMOND, NY

DICHLOROMETHANE



TOTAL NUMBER OF OBSERVATIONS: 97

Data: October/87 thru September/89

Figure 6a: Key to Pollutant Rose

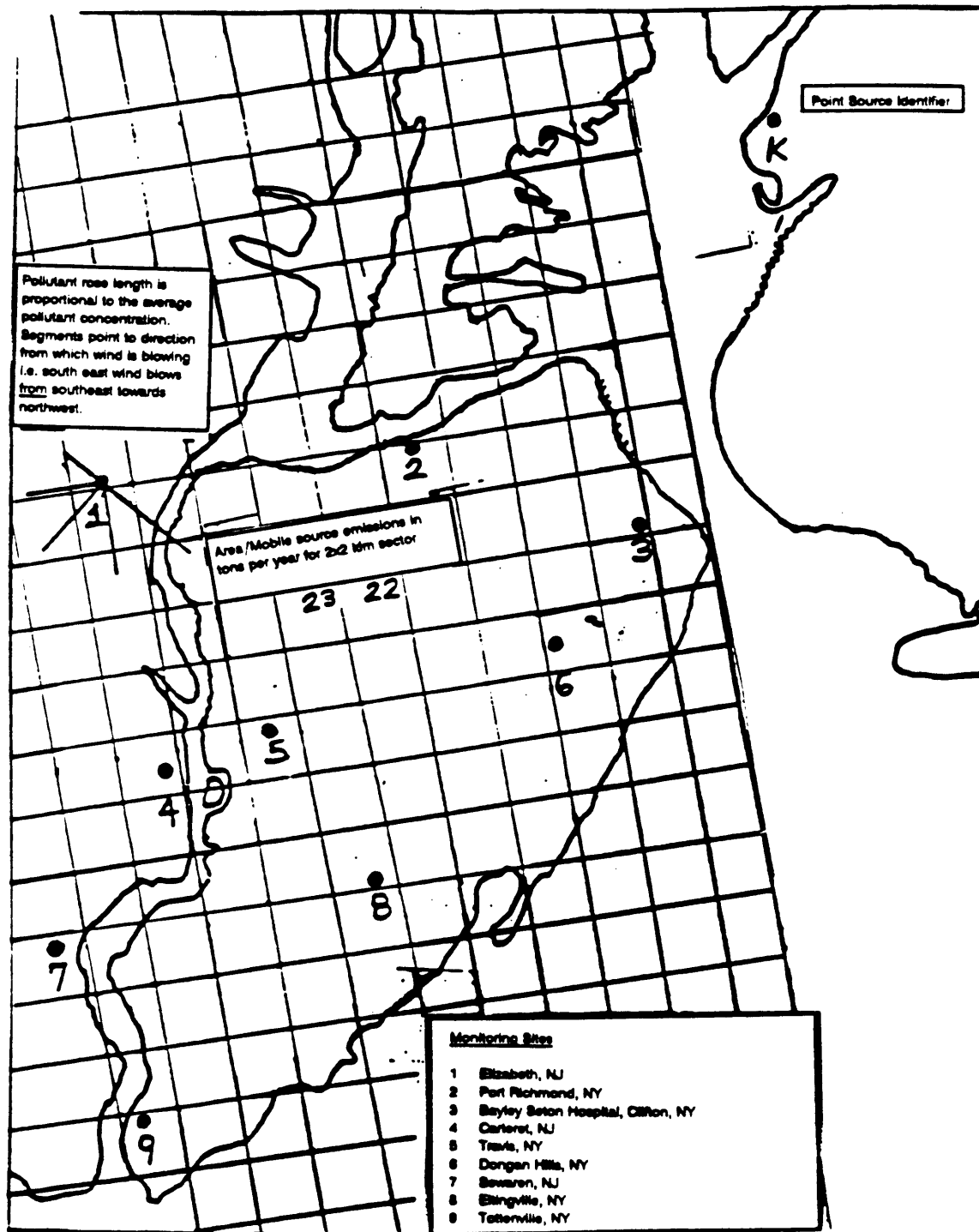


Figure 6b : Rose A, Benzene Year 1

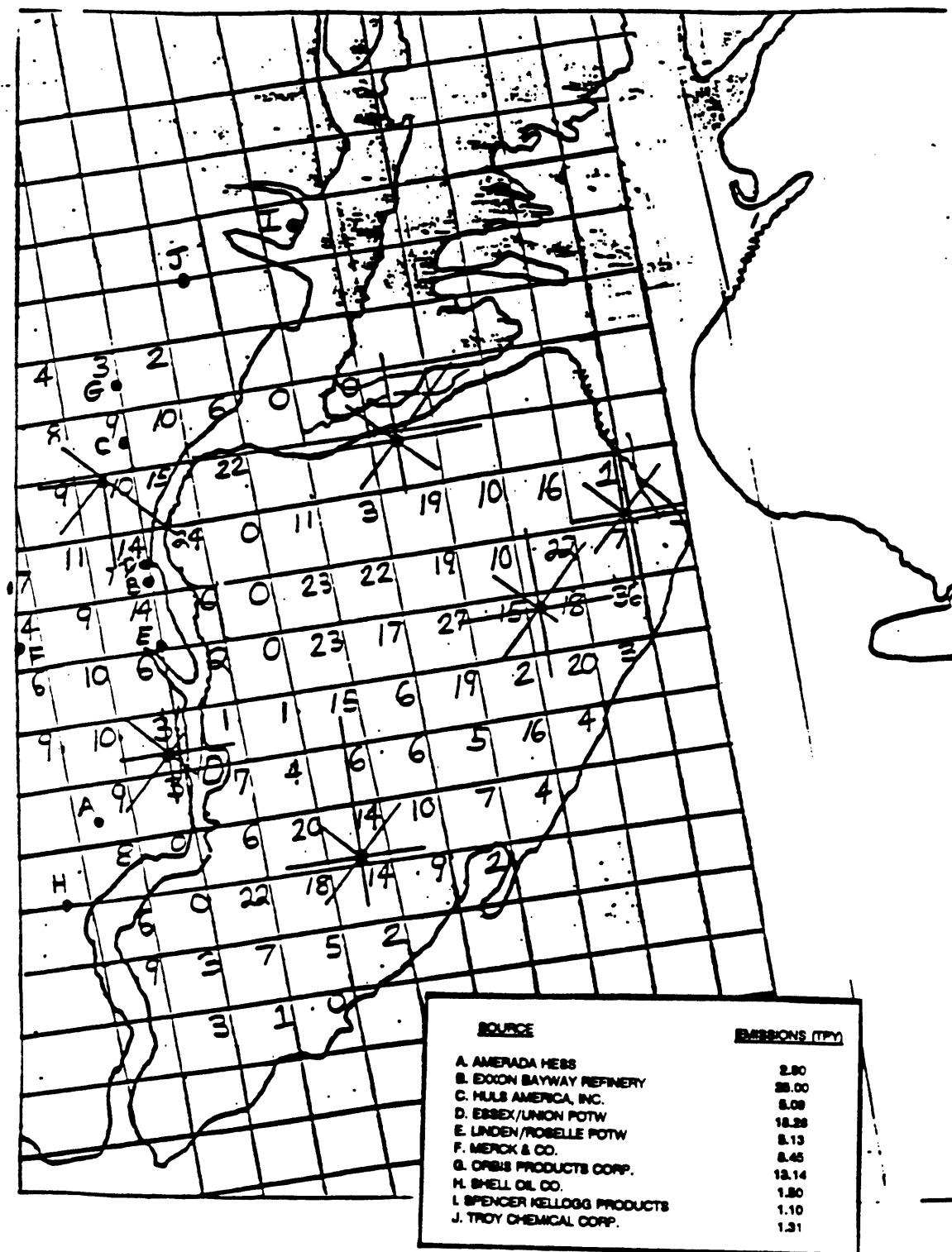


Figure 7
Key to Figures 8 through 10

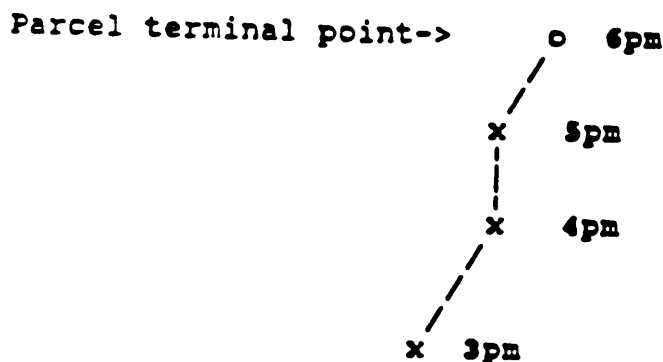
INTERPRETING SURFACE TRAJECTORY OUTPUT

BACKGROUND

The surface trajectory model prints output as a backward surface trajectory of an atmospheric parcel; that is, assuming one is standing at the point of origin, the location of the air packet is traced back in time.

EXAMPLE

Consider a 3 p.m.-6 p.m. trajectory. This trajectory assumes that a parcel of air is located at the origin at 6 p.m., with the positions of the parcel at 5, 4, and 3 p.m. indicated by successive points which are connected by straight lines. To cover the 24-hour period of each air sample, the trajectory maps contain eight three-hour trajectories superimposed on the same map of the project area; therefore, one must carefully follow the trace of separate trajectories on the map. The solid square symbol completely obscures the other symbols at the parcel terminal point; i.e., the 6 a.m. point obscures the 12 noon, 3 p.m., 6 p.m., 9 p.m., 12 midnight, 3 a.m., and 9 p.m. points on each map.



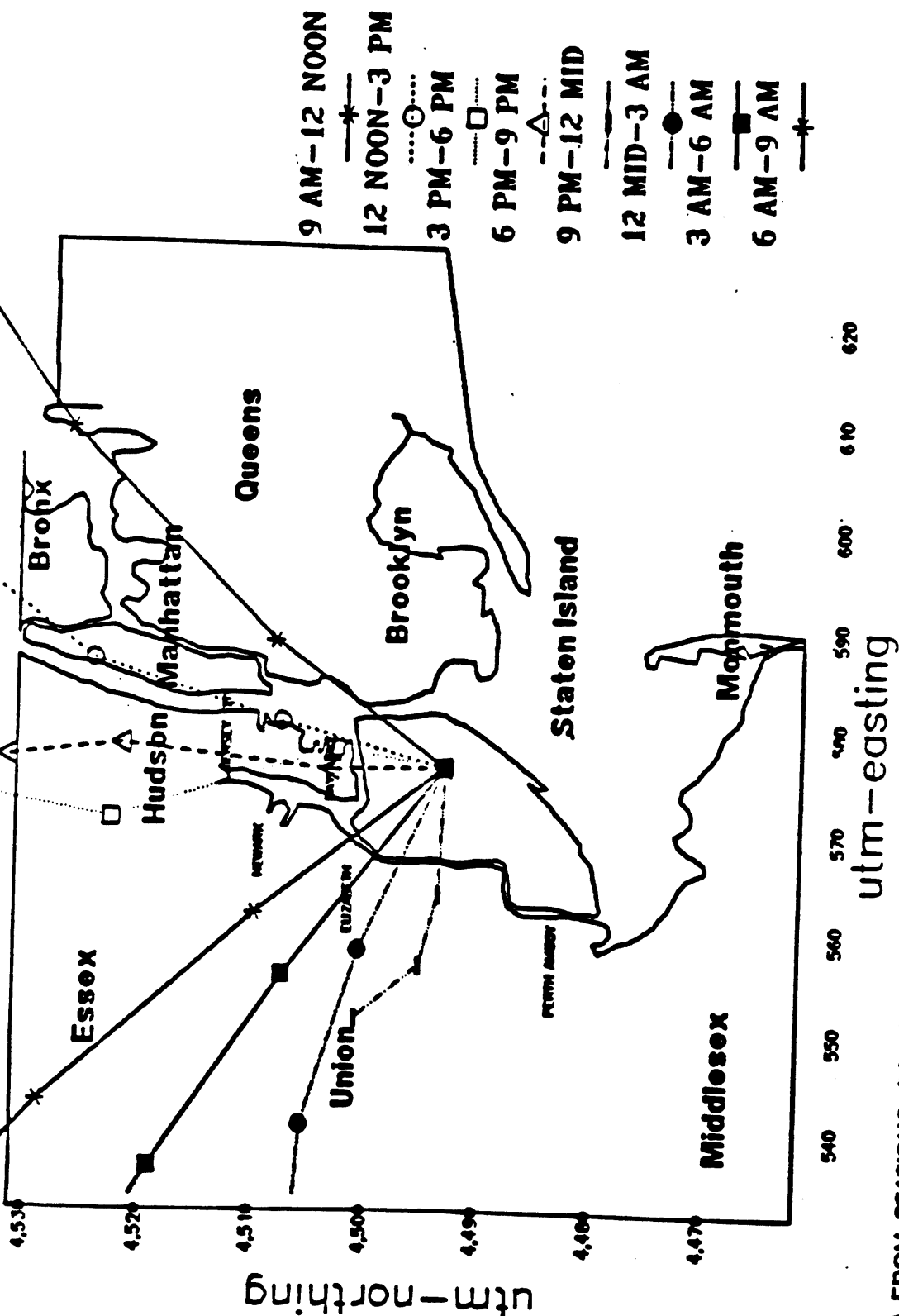
Consistent trajectories, i.e., those with eight lines which more or less followed each other very closely, could indicate or point out source areas of pollutants. In some instances trajectory consistency was observed; in others it was not, especially during periods of air stagnation and recirculation.

Sometimes, only one or two previous hours are observed on the trajectory; in these instances, wind velocities were relatively high and the missing points are beyond the map boundary, in Pennsylvania, western New Jersey, or eastern Long Island, for example.

Figure 8 : Winds from varied directions

SURFACE TRAJECTORY PLOT - 2/15-16/89

Ending Point: Susan Wagner High School

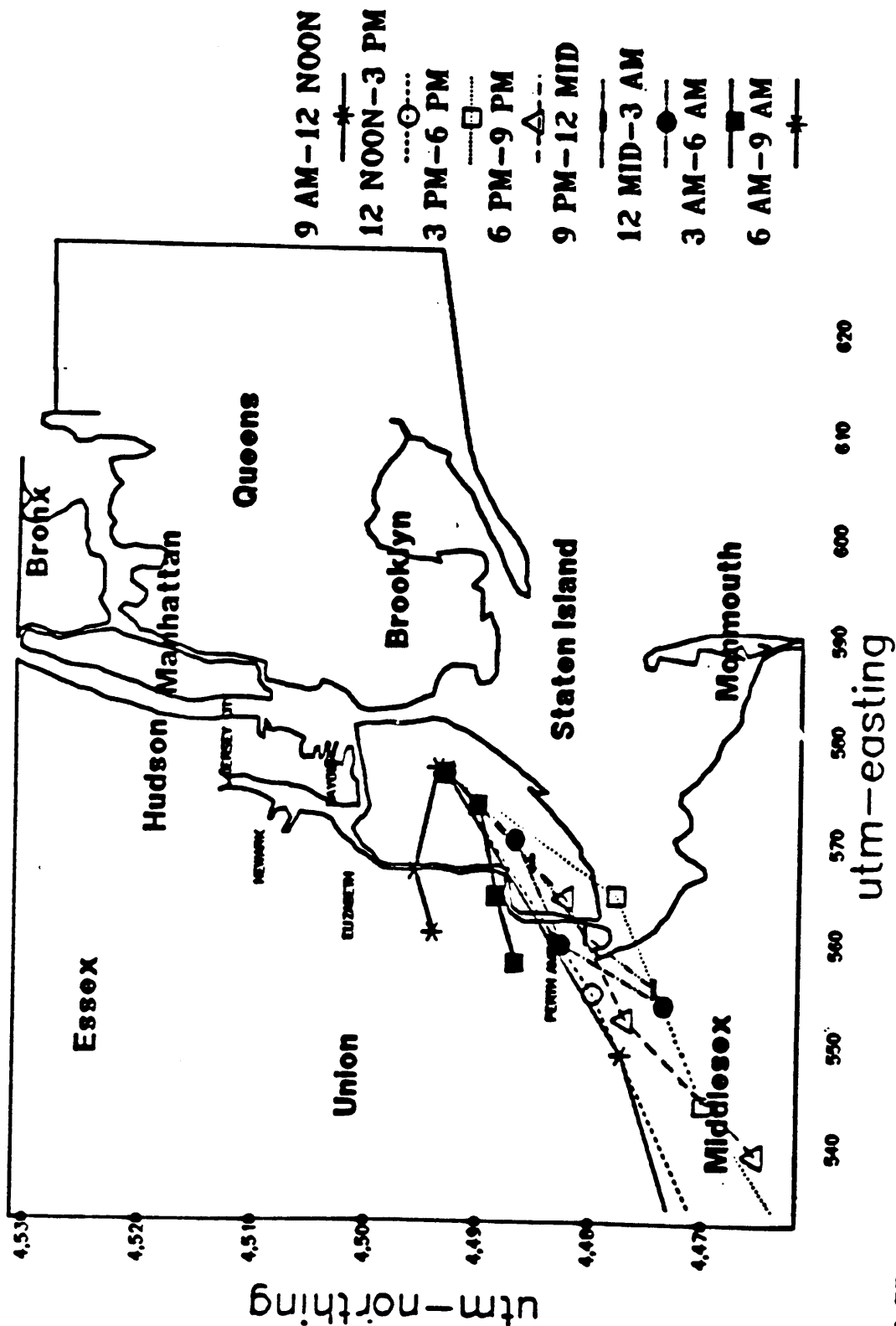


MET DATA FROM STATIONS #1-7

Figure 9 : Winds from one general direction in 24-hour period

SURFACE TRAJECTORY PLOT - 1/22-23/89

Ending Point: Susan Wagner High School

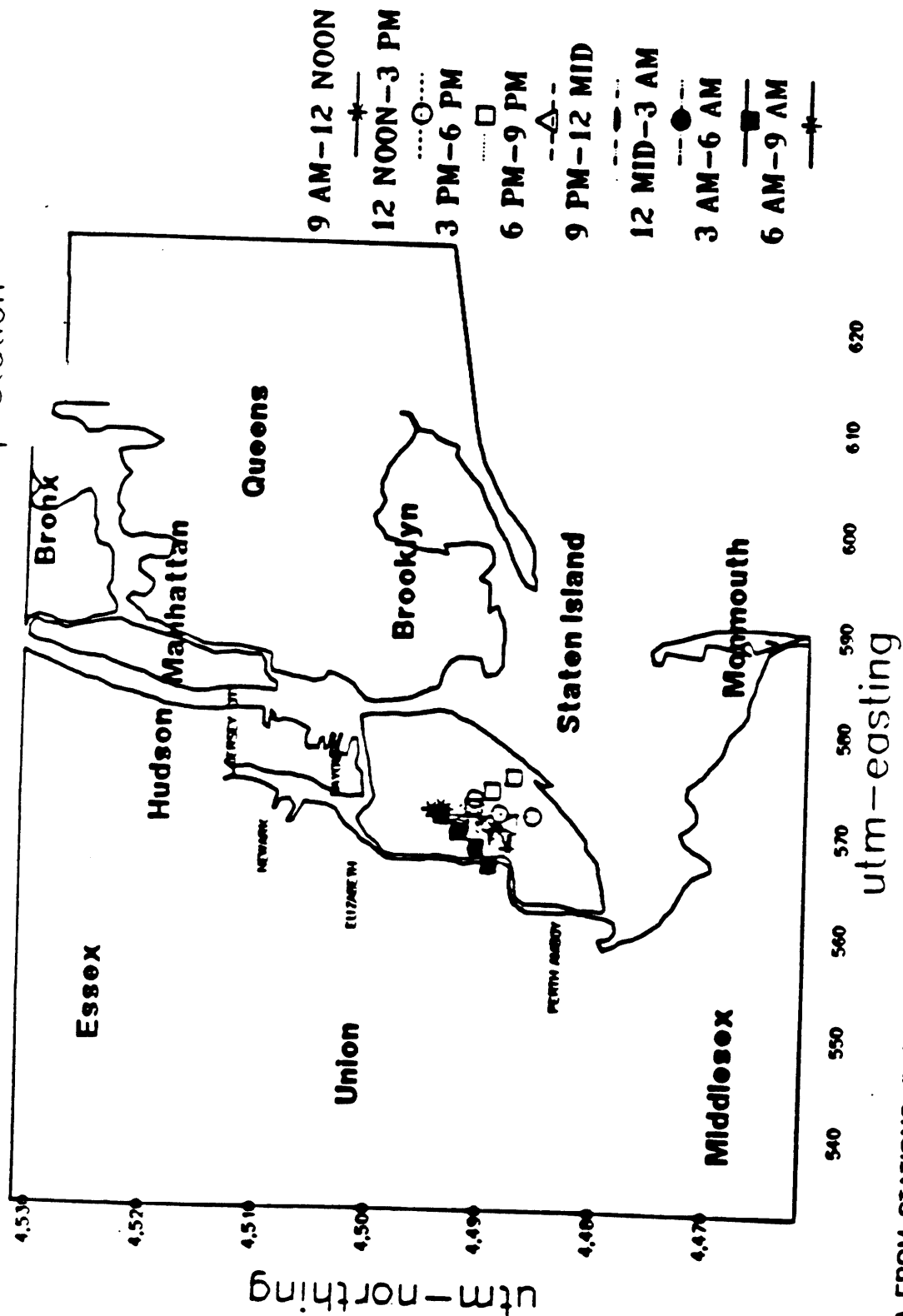


MET DATA FROM STATIONS #1-7

Figure 10: Stagnation

SURFACE TRAJECTORY PLOT - 3/11 - 12/89

Ending Point: Richmond Rd. Pump Station



MET DATA FROM STATIONS # 1 - 5

Table II: Summary of source category contributions to the air toxics emission inventory
(Estimated air emissions in tons per year, tpy)

	Benzene	Cadmium	Carbon Tetrachloride	Chloroform	Dichloro- methane	Formaldehyde	n-Hexane	Perchloro- ethylene	Toluene	1,1,1- Trichloro- ethane	Trichloro- ethylene	Xylene (all isomers) ¹
AREA SOURCES ²	79.75	0.42	0.00	0.00	72.77	65.38	NA ³	789.52	492.03	260.14	79.14	503.65
% of total	(5.5%)	(7.0%)	(0.0%)	(0.0%)	(9.0%)	(12.0%)		(65.7%)	(8.2%)	(28.5%)	(19.6%)	(14.0%)
MOBILE SOURCES ²	1,281.89	0.00	0.00	0.00	0.00	412.58	317.55	0.00	1,757.48	0.00	0.00	1,961.87
% of total	(88.1%)	(0.0%)	(0.0%)	(0.0%)	(0.0%)	(75.1%)	(29.4%)	(0.0%)	(29.2%)	(0.0%)	(0.0%)	(54.8%)
POINT SOURCES ⁴	93.08	5.56	469.73	25.22	734.58	70.76	779.27	411.80	3,765.20	653.00	323.86	1,112.51
% of total	(6.4%)	(93.0%)	(100.0%)	(100.0%)	(91.0%)	(12.9%)	(71.0%)	(34.3%)	(62.6%)	(71.5%)	(80.1%)	(31.1%)
TOTAL TPY	1,454.72	5.98	469.73	25.22	807.35	548.72	1,096.82	1,201.32	6,014.71	913.14	403.00	3,578.03

¹ "Xylene (all isomers)" includes xylene (mixed isomers) (CAS# 1330-20-7), m-xylene (CAS# 108-38-3), o-xylene (CAS# 95-47-6), and p-xylene (CAS# 106-42-3).

² Table III-5-19.

³ "NA" means data were not available.

⁴ Tables III-5-4 through III-5-18.

Table 12: Summary of Risk (Cancer and Noncancer) from Median Annual Average Concentrations of Pollutants Addressed in the Level 1 Risk Assessment

<u>Chemical</u>	<u>Median Cancer Risk (per million)^a</u>	<u>Median Hazard Quotient^a</u>	<u>Number of Sites^b</u>
Arsenic	20	- ^c	2
Benzene	40	2	12
Benzo[α]pyrene	0.38	-	4
Cadmium	5.1	0.1	4
Chromium	30 ^d , 3 ^c	1.2 ^f , 0.12 ^g , 0.2 ^h	2
Dichloromethane	1.2	0.0008	6
Ethylbenzene	-	0.03	3
Formaldehyde	0.26	0.1	2
Hexane, n-	-	0.2	6
Lead	-	0.03 ⁱ	4
Manganese	-	0.04	4
Mercury	-	0.002	2
Nickel	6.0	1	4
Tetrachloroethene	1.0	0.05	12
Tetrachloromethane	12	0.4	12
Toluene	-	0.04	12
Trichloroethene	0.8	0.02	12
Trichloromethane	6.2	0.009	12
Vanadium	-	0.1	2
Xylene, o-	-	-	12
Xylenes, p- and m-	-	-	12
Zinc	-	0.003	4
TOTAL	123^d, 96^c	5.3^f, 4.2^g, 4.3^h	

Footnotes

^a The background sites were excluded when determining the median annual average concentrations.

^b Number of sites contributing annual average concentrations to the medians.

^c Dash indicates that the Inhalation Unit Risk Factor or the Reference Concentration was not available so that the cancer risk or Hazard Quotient could not be calculated.

(Footnotes continued on next page.)

Table 12, continued

- ^d Assuming 10% chromium VI. The cancer risks associated with chromium exposure were calculated assuming that 10% or 1% of the total reported chromium concentration is in the hexavalent oxidation state (Cr VI). In the ambient environment, chromium is found in the Cr VI and Cr III forms. Only Cr VI has been shown to be carcinogenic; the cancer unit risk factor is based on exposure to Cr VI. See text for further detail.
- ^e Assuming 1% Cr VI. See footnote d above.
- ^f Using the former HEAST RfC and assuming that 10% of the total reported chromium concentration is Cr VI. See text for further detail.
- ^g Using the former HEAST RfC and assuming that 1% of the total reported chromium concentration is Cr VI. See text for further detail.
- ^h Using the NYSDOH RfC for total chromium. The NYSDOH RfC is based on different toxicological studies from those used to develop the former HEAST RfC. See text for further detail.
- ⁱ In the absence of either an Inhalation Unit Risk Factor or a Reference Concentration, the current National Ambient Air Quality Standard (NAAQS) for lead was used in place of an RfC in the Hazard Quotient calculation. EPA, currently reevaluating the standard, plans to publish a notice in the Federal Register concerning a proposed new NAAQS for lead.

Table 13: Noncancer Additive Risk Analysis by Target Organ

<u>Effect Associated with Chemical Exposure</u>	<u>Hazard Quotient from Table V-1-24</u>
Respiratory Tract (Irritation)	
Chromium	1.2 ^a , 0.12 ^b , 0.2 ^c
Formaldehyde	0.1
Manganese*	0.04
Nickel	1.0
Vanadium	0.1
Zinc	0.003
TOTAL HI, Respiratory	2^a, 1^b, 1^c
Liver Effects	
Ethylbenzene**	0.03
Trichloromethane	0.009
Tetrachloromethane	0.4
Trichloroethene	0.02
Tetrachloroethene	0.05
Xylenes (m-)	- ^d
TOTAL HI, Liver	0.5
Hematopoietic System	
Benzene	2.0
TOTAL HI, Hematopoietic	2
Kidney	
Cadmium	0.1
TOTAL HI, Kidney	0.1
Central Nervous System	
Lead	0.03
Mercury***	0.002
Dichloromethane	0.0008
Hexane n-	0.02
Toluene	0.04
Xylene, o-	- ^d
TOTAL HI, CNS	0.1

Footnotes

- * Developmental toxicity and effects on the kidney are also associated with exposure to manganese.
- ** Effects on the central nervous system have been associated with exposure to ethylbenzene.
- *** Effects on the kidney have been associated with exposure to mercury.
- a Assumes the former HEAST RfC and 10% Cr VI in the total reported chromium concentration.
- b Assumes the former HEAST RfC and 1% Cr VI in the total reported chromium concentration.
- c Assumes the NYSDOH RfC for total chromium.
- d The RfC in the 1991 HEAST does not appear in 1992 update; no RfC is available currently.

Table 14 : RESULTS OF THE STATEN ISLAND CITIZEN'S ODOR COMPLAINT NETWORK

**Summary of analytical results for canister samples taken by
a group of residents during the period from October 1989
through August 1990**

<u>Compound</u>	<u># of Samples in which compound was detected*</u>	<u>Concentrations , PPbv</u>		
		<u>MAX</u>	<u>MIN</u>	<u>MEAN</u>
BENZENE	24	5.60	0.65	2.2467
CHLOROFORM	2	21.10	0.09	0.5950
CHLOROMETHANE	7	1.35	0.53	0.9429
1,3-BUTADIENE	2	0.82	0.57	0.5950
P-DICHLOROBENZENE	13	0.60	0.07	0.2239
ETHYLBENZENE	24	2.50	0.24	0.7796
HEXANE	10	2.90	0.21	1.4130
METHYLENE CHLORIDE	20	12.71	0.58	2.4090
N-OCTANE	6	0.90	0.41	0.6467
STYRENE	14	1.20	0.02	0.3250
TETRACHLOROETHENE	22	4.16	0.29	0.7118
TOLUENE	24	19.00	0.64	6.6092
1,1,1-TRICHLOROETHANE	15	17.39	0.26	2.2307
TRICHLOROETHENE	9	1.40	0.03	0.3511
O-XYLENE	24	3.50	0.35	1.1392
M/P-XYLENE	24	15.00	0.53	4.0563
PROPYLENE	9	7.23	1.06	2.8289

*24 valid samples



United States
Environmental Protection Agency
Region 2
Jacob K. Javits Federal Building
New York, NY 10278

Official Business
Penalty for Private Use
\$ 300

EPA/902/R-93-002